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THE COST OF COAL[1]

The price of coal is a matter of vital concern to the average citizen. No less important, however, is the question what our coal actually costs to produce and the interest in this subject is typical of the popular interest in the large productive enterprises of the country. As citizens we recognize the consumer's dependence upon the producer and are taking advanced ground as to their relative rights. In few industries does this dependence seem more vital or the consumer's equity appear larger than in that of producing and selling coal. The per capita annual expenditure for the useful metals is roughly equivalent to that for coal, but few citizens purchase pig iron or bar copper, whereas of the urban population only the dwellers in apartments, boarding-houses and hotels are spared the necessity of buying coal. The consumption of coal in the United States for heating and cooking is between 1 and $1\frac{1}{2}$ tons per capita. A careful estimate for 1915 is 1.1 tons, which happens to be identical with the figure determined for similar consumption in Great Britain in 1898. This non-industrial consumption is greatest in cities and in this city of Chicago in 1912 it was nearly 2 tons. Of course every citizen indirectly pays for his share of the total consumption, which last year amounted to 4.6 tons per capita.

Again it may be that because to a larger degree the cost of metals is charged to capital outlay rather than to the operating expense of life, we appreciate less keenly the unit price of these materials that are

[1] Read before the American Mining Congress, Chicago, November 14.

not immediately consumed with the using. At any rate, public opinion is more easily brought to a high temperature by considering the price of coal than by considering the price of any other product unless we except gasoline, recent discussion of which has been almost explosive.

Looking backward as well as forward, one need not be an alarmist to suggest that in the whole field of productive business the coal industry seems the one most likely to be threatened with government operation. The foodstuffs are produced on land owned and operated by the millions, and so far as the production of the raw material for them is concerned, "monopoly" is an unknown word, but when we think of coal, terms like "barons" and "trusts" instinctively come to mind. For these reasons the determination of certain facts connected with coal production and the analysis of the cost elements that enter into the price of coal constitute a timely subject for discussion.

In discussing costs, however, we do not overlook the too evident fact that at times price may far outstrip cost. The price of coal depends upon the balance between necessity for fuel, on the one hand, and ability to produce and to deliver, on the other; the ability to produce is in turn controlled by the labor available and the ability to deliver is dependent upon car supply. Increased foreign demand for American coal, large industrial consumption, unusual weather—all may have great influence on the current price of coal, but none of these is to be considered a factor in the actual cost of production except so far as it causes irregularity in operating expenses and promotes a decrease in efficiency of mine labor. To-day high prices are being received for coal by those who are able to produce and deliver more than their outstanding contracts require. In other words, a few traders may be able and willing to capitalize the urgent necessity of the consumer and their own ability to deliver. The premium for fuel now being paid generally by the consumers of the country and by such traders as have been caught short in their contracts is in reality not properly chargeable to cost of coal, but to cost of car and labor shortage, just as in the times of stress accompanying labor troubles the premium paid by their consumers is a part of the price the country pays for strikes.

Four general items of cost must be considered as normally controlling the price of coal to the consumer—resource cost, mining cost, transportation cost and marketing cost. Under usual conditions each of these items includes a margin of profit which may seem either excessive or inadequate, according to your point of view. Yet an unbiased consideration of these cost items is absolutely essential as a preliminary to the decision by the public whether we are buying coal at a fair price, and if not why not. As long as it is the popular view that the price of coal is made up of one part each of mining costs and freight costs to two parts each of operator's profits and railroad dividends, with the cost of a certain amount of needless waste on the side, the demand for investigation will continue, and in so far as there is any element of truth in this view, legislative action is justified, even though the prescribed reform may approach the extreme of public ownership and operation of mines and railroads.

As the initial item of cost, the amount charged against the marketed product as the value of the coal in the ground, which for brevity may be termed the resource cost, is perhaps the item most often overlooked by the coal consumer, and for this reason that phase of the subject will be fully considered after the other items are

treated. These other items need less discussion in this paper for several reasons: the item of marketing cost is one that can be brought directly under observation by the consumer if he will but study the matter intelligently, the transportation cost can be learned by simple inquiry and its control lies within the province of the Interstate Commerce Commission, and the details of mining cost can best be set forth by the mine operators themselves, for they have now adopted the policy of free discussion of these matters, which they once regarded as sacred from public view. The purpose of this paper, then, is simply to give a summary statement of all these elements in the cost of coal, and some special discussion of the resource cost. In presenting the subject, the senior author assumes responsibility for whatever may be regarded as mere expressions of opinion and the junior author stands behind the statements of fact.

The item of cost first to be considered represents that part of the value given to the ton of coal by the mine operator and the mine worker. This may be termed mining cost, but it must include the operator's selling costs and other overhead expenses as well as the mining costs proper, which include the larger expenditures for wages, supplies and power. This cost plus the resource cost—the royalty or depletion charge—and the profit or loss on the sale make up the value at the mine mouth. The mining cost varies not only between mines of different companies in separated fields, but even between adjacent mines of the same company in the same field. Both nature and man contribute to such variation.

It is not practicable to assign a very exact figure to the mining cost—the census of 1909 indicated an average of $1 a ton for bituminous coal and $1.86 for anthracite, but these figures are believed by some operators to be too low. It is possible, however, to show in a general way the distribution of this item; the cost of mining is divided between labor, 70 to 75 per cent.; materials, 16 to 20 per cent.; general expense at mine and office and insurance, 2 to 4 per cent.; taxes, less than 1 per cent. to 3 per cent. for bituminous coal, and 3 to 7 per cent. for anthracite; selling expenses, nothing to 5 per cent., and recently to these items has been added the direct and indirect cost of workman's compensation, which may reach 5 per cent. for bituminous coal. The charges for labor, material and general office expenses are easily understood, as is also a charge for depreciation of plant and machinery; but taxes and selling expenses are important items that may be overlooked by the casual observer. Some figures recently published show that the taxes levied in West Virginia last year on coal lands and coal-mine improvements—that is, on the industry as a whole—were equivalent to nearly 3 cents per net ton of coal produced, which is doubtless fully as much as the profit made by many of the operators in that state.

The cost of selling coal is nothing for the companies that use their own product, including the steel corporation and a large number of others, and is little or nothing for the producers who sell nearly all their coal to such large consumers as the railroads. Companies that produce coal for domestic use and the general run of steam trade must figure on a selling cost as high as 10 cents or more per ton, the cost depending on the extent of their business. The average selling cost for bituminous coal is probably 5 to 10 cents a ton, and for anthracite the usual charge of sales agencies is reported as 10 cents a ton for steam sizes and 15 cents for the prepared sizes.

The producers of coal and the transportation companies are concerned not so much with the actual rates charged for carrying coal as with the adjustment of rates between different coal fields and between different markets. In the many years in which our coal industry has been developing, rate structures have been built up that give to this and that producing district differentials over other districts—"handicaps," as it were—that may be based on comparative lengths of haul or on the ability of the coals to compete by reason of difference in quality or in cost of mining or perhaps may be merely the survival of past practise, for which no reason now exists. The consumer of coal, however, is interested in the actual rather than the relative freight rate.

To help toward a realization of the magnitude of this transportation item, it may be pointed out, first, that all but 14 per cent. of the output of the country's coal mines, aggregating 532 million tons, is moved to market by rail or water, and second, that nearly half of the bituminous coal (47 per cent. in 1915) and more than two thirds of the anthracite (71 per cent. in 1915) is shipped outside of the states in which it is produced.

Add to this statement of the extent to which coal enters interstate commerce a glance at the distribution of centers of maximum production and maximum consumption—the New York–Baltimore industrial zone, which has a total per capita consumption of nearly 10 tons and lies 100 to 400 miles from the tributary coal fields; New England, consuming about 7 tons to the unit of population and lying 400 to 800 miles from its coal supply; or the populous industrial district of which Chicago is the commercial center, consuming 8 to 9 tons per capita of coal in part hauled more than 400 miles from the fields of West Virginia and eastern Kentucky and in part 200 miles or less from the Illinois mines. With these facts in mind we must realize that the transportation cost is necessarily a large part of the country's fuel bill.

As has already been suggested, the transportation rate in force from any coal field to any market can readily be learned by the consumer who wishes to figure this item in the cost of the coal he buys. Therefore in the present general consideration of the subject it is sufficient to state the average value of this item. In the interstate traffic, both rail and water, bituminous coal probably pays an average freight of nearly $2 per ton. In other words, the transportation costs more than the product and, as some parts of the country are just now learning, is sometimes more difficult to obtain. The value of coal, like the value of so many other commodities, is a place value.

The average freight charge on anthracite is higher than that on bituminous coal, first because the rates are higher and second because, according to the reports of the Interstate Commerce Commission, *all* movement considered, the coal is carried a greater distance.

The cost of handling the coal, exclusive of freight, from the time it leaves the producer until it is in the consumer's fuel bin, may be termed the marketing cost. It can readily be seen that a large part of the coal produced is not subject to this cost, for most large users of steam coal, such as the railroads and the coke manufacturers, place contracts directly with the producing companies or their selling agencies and buy in the open market only when their needs exceed the deliveries under their contracts. Much of the coal, however, both anthracite and bituminous, passes through the hands of a wholesale dealer or jobber before it is received by the retail dealer who puts it in

our cellars or in the bins of a power plant. Coal that gets a long way from the mine may pass through many hands before it reaches the consumer, and it not only pays commissions all along the line, but is subject to shrinkage and deterioration, both of which enter into the final selling price to the consumer. Brokers are usually satisfied to make a gross profit of perhaps 10 cents a ton, but as several brokers may make a "turn over" on the same car before it is unloaded this element of cost may be several times that amount.

About half of the anthracite and around 15 per cent. of the bituminous coal is retailed in less than carload lots, and the greatest number of individuals are directly concerned in the marketing of this portion, regarding the profits on which there is the widest divergence of opinion. The margin in the retail business between cost on cars and price delivered is between $1.25 and $2.00 a ton and is not more than enough to give on the average a fair profit. The shrinkage and, in part, the deterioration are together seldom less than 1 per cent. of the weight and may exceed 4 per cent., and the retail dealer also must provide in his selling price for uncollectable accounts.

Advertising is a large expense—in part carried by the retailer directly, but all borne by the industry. The largest single item in the cost of retailing is of course that representing the labor of handling and the local cartage, which together make up about half the marketing cost.

There now remains to be considered the first major item, or the resource cost, which is what the operator has to pay for the coal in the ground—the idle resource, which he starts on its career of usefulness. This cost is expressed as a royalty or a depletion charge.

One of the latest leases by a large coal-land owner provides for the payment of 27 per cent. of the selling price of the coal at the breaker. This percentage is therefore not only a royalty figured on the mineral resource, but also a commission based on the miner's wage. To bring this right home to you and to me, it may be said that the practical result is that if the anthracite we burn in our range this winter happens to come from that particular property, we will pay fully $1 a ton into the treasury of the city trust that owes its existence to the far-seeing business sense of a hard-headed citizen of Philadelphia. Whether such a royalty is excessive or not, the fact remains that this is the tribute paid to private ownership.

The present average rate of royalty on anthracite is probably between 32 and 35 cents a ton on all sizes, which is from 12 to 14 per cent. of the selling value at the mine. The minimum rate (about 10 per cent.) is found in some old leases, and the maximum (20 to 27 per cent.) in leases made in the last five years. R. V. Norris states that in the late sixties, when the annual output of anthracite was around 15,000,000 tons, royalties were 8 to 10 cents a ton on prepared sizes, but that no charge was made on the smaller sizes. In the seventies the rate rose to 25 cents on prepared, one half that on pea, and one fourth on smaller sizes. By the middle eighties, when the output was a third what it is now, the rate was about double that of the seventies—that is, 40 to 50 cents on the larger sizes and 5 to 10 cents on the smaller sizes. The tendency is still upward by reason of increases in the rates for intermediate sizes and the operation of royalty rates based on a percentage of the selling value, an increasing quantity. Figured on the output from the Girard lands, which is nearly 3 per cent. of the total production, the gross return to the estate from its coal lands is over 50 cents a ton.

Nor is the increase in value of anthracite lands any less striking. At the beginning of the last century, as stated by Mr. Norris, the great bulk of these lands were patented by the State of Pennsylvania for $2 to $4 an acre; in the middle of the century the price of the best land rose to $50, and in 1875 even to $500. Now $3,000 an acre has been paid for virgin coal land, and little is on the market at that. In considering these increases in land values, the effect of interest and taxes must not be overlooked.

The bituminous coal industry is a modern institution compared with the mining of anthracite, and much of the bituminous coal land was acquired by the operating companies during the last twenty years for little if anything more than its surface value. To-day there are large areas of bituminous coal-bearing lands that, because they are undeveloped and without railroads, can be purchased at a low price, but little or no anthracite land is on the market, and little has changed hands for years. The present average resource cost of bituminous coal is not much over 5 cents a ton, or about 4 per cent. of the average selling value at the mine. In the Pocahontas region and the Pittsburgh district the royalties are much higher, but these, like others that might be cited, are exceptions—one due to coal of special quality, and the other to location—factors which, incidentally, are exactly those that have assisted in making the resource cost of anthracite what it is.

Should you be interested in summing up all these various costs and striking a balance between labor's share and capital's return, you would find that the mine worker, the trainman, and the wagon driver together receive fully half of the price of the anthracite delivered at your house, and the same three classes of labor receive not less than half the price paid by the average consumer for the cheaper soft coal. In a similar manner the average return on the capital invested in land, mining plant, railroads and coal yard may be roughly calculated, with the result that landlord, bondholder and stockholder of coal company and railroad together receive about $1.15 from the ton of anthracite and only 50 to 75 cents from the ton of bituminous coal, and of either of these amounts the mine operator's share is only a small fraction.

It is not the purpose of this analysis of costs to offer any cure-all for the high price of coal, yet some comment on the facts presented may possess value. At least certain lines of approach can be pointed out as not very promising. For example, any one who is at all cognizant of the trend in price of labor and material can see little hope of relief in lower costs for these items. Furthermore, observation of the advances made in mining methods in the last decade or two affords slight warrant for belief in any charge of wasteful operation. As consumers of coal we might do well to imitate the economy now enforced by the producers in their engineering practise. In the northern anthracite field machine mining in extracting coal from 22- and 24-inch beds, and throughout the anthracite region the average recovery of coal in mining is 65 per cent., as against 40 per cent. only twenty years ago. Nor are the bituminous operators any less progressive in their conservation of the coal they mine.

Yet it must be remembered that conservation of a natural resource, though it will undoubtedly be of direct economic benefit in the future, is not essentially a cheapening process; in fact, these increased recoveries of coal have in large part become possible only because of a higher market price. And, following further this line of thought, we may say that the increased

safety in the coal mines that has come through the combined efforts of the coal companies, the state inspectors, and the Federal Bureau of Mines necessarily involves some increase in cost of operation, but the few cents per ton thus added to the cost is a small price to pay for the satisfaction of having the stain of blood removed from the coal we buy. That form of social insurance which is now enforced through the workman's compensation laws alone adds from 2 to 5 cents a ton to the cost of coal.

In the item of transportation perhaps the most promising relief is that of reducing the length of haul. Though many a consumer's preference for coal from a distant field over that from a field nearer home is based on special requirements, the deciding element in the preference of other consumers is simply the price, and this in turn may be largely due to a differential freight scale, which is thus not in the public interest if we admit the premise that it is wasteful to burn coal in hauling coal into coal districts or past such districts, except in so far as quality requirements absolutely demand the long-haul coal. The recent eastward movement of the higher-grade coals, in part caused by the expert demand, may involve some increase in the average length of haul and thus in the transportation cost of coal not exported, but, on the other hand, this enforced adjustment may lead some consumers to discover nearer home sources of coal equally well suited to their purposes.

Reduction in marketing costs is a reform so close to the consumer that he should be able to find for himself whatever relief is possible. Professor Mead, of the University of Pennsylvania, is authority for the statement that the delivery of coal is costing the dealers 50 cents a ton more than is necessary.

There only remains, therefore, the first item of all—the value of the coal in the ground, or rather the return which the land-owner is asking for this natural resource. The fortunate holder of coal land, whether a very human individual or a soulless corporation or a large trust estate administered for benevolence only, is likely to endeavor to get all that the traffic will bear. Especially in the possession of a limited resource like anthracite, the tendency has been and will continue to be to increase royalties as the years pass, and the only penalty imposed by the state for high royalties seems to be high taxes, which too often, indeed, serve to justify the high resource cost put upon coal in the ground. Finally, in considering royalty rates or depletion charge we must not overlook the interest that accumulates throughout the period between the purchase of the coal land and the removal of the last ton of coal.

In placing a value upon the Choctaw land some years ago the Geological Survey figured the aggregate royalties at current rates as 160 million dollars, but if that amount of royalty were to be collected through the six or seven centuries required for mining the 2,000 million tons under this land, the present value of the land would be only 6½ million dollars if purchased by the federal government or only 4 million if purchased by the state of Oklahoma, and even less if the project were financed by a corporation that would need to issue 6 per cent. bonds. Such is an illustration from actual experience in coal-land valuation—the 4 or 6 million dollars invested in these Oklahoma coal lands now would require a final return of 160 million dollars in royalties to balance the account.

More recently Mr. Cushing, the editor of *Black Diamond,* has figured the cost of a monopolistic control of the available coal resources east of the Rocky Mountains on

the basis of the United States Geological Survey estimate of 2,000,000 million tons. At a valuation of coal in the ground of only 1 cent a ton, which he stated is less than has been paid for large holdings, this deal would require a capitalization of 20 billion dollars, and the fixed charges on the bonds of this United States Coal Corporation would require an interest charge alone of $2 a ton against a production of 600 million tons a year. Mr. Cushing characterizes such a financial undertaking in mild terms as hopelessly impossible, and yet his figures, which do not include taxes, are most enlightening as affording some measure of the cost of possessing an undeveloped resource. Incidentally, these startling figures furnish a strong argument for the present policy of the national government in retaining ownership of the public coal lands, at least up to the time when the market conditions justify the opening of a mine and then either leasing or selling a tract only large enough for that operation. The consumer of the next century simply can not afford to have private capitalists invest to-day in coal land for their great-grandchildren to lease.

The burden that seems inevitable under unregulated private ownership of a natural resource like coal is that because the lands containing these national reserves of heat and power are taxed and because the individual or corporation properly charges up interest at current rates on his large holding, the consumer must pay a resource cost which takes into account the long period of undevelopment. Even the high rates of royalty on the lands of the Girard estate may be found less excessive than they seem if a century's taxes and interest charges are figured. Yet the fact remains that the royalty for anthracite represents a much larger proportion of the cost of the mined coal than any bituminous royalties. Moreover, we believe the highest royalty prevailing in the anthracite region has far more influence in fixing the selling price than the lower rates of the older leases.

Any study of costs in the coal industry finds its point in the question not who, but what, fixes the price of coal. The cost of mining coal, like the cost of living, is increasing. Exact mining costs, however, can not be determined until the operators have accomplished their reform of standardizing accounting. Too often the operator includes in his account only the two largest and most obvious items, labor and material. Thus, when the market for bituminous coal is dull, the company whose land costs little or nothing is able to set a lower limit of price than the company whose coal must stand a charge of 5 to 10 cents per ton or even more, be that charge called royalty, depletion or amortization. At such time the operator with the large resource cost must sell at a real though not always recognized loss, but of course with the hope of recouping himself at times of high prices like the present, if fortunately he has any coal to sell not already contracted for.

Even with the average low resource cost of bituminous coal, the state of competition that is tied up with idle and half-worked mines results in an average total cost that is little below the average selling price. Of course in this business there are those, both large operators and small, who make a profit in lean as well as in fat years, just as there are those for whom the prosperous years are too infrequent to keep them out of the hands of receivers.

In the anthracite fields the mining costs, and especially the resource costs, are higher. But here, with an average market demand that normally exceeds or at least equals the available supply (and with the passing

years this disparity must be expected to increase), there results naturally a lack of competition for the market. Even gentlemen's agreements are unnecessary so long as every operator can reasonably expect to sell his product, and the market price of anthracite at the mine must therefore tend to be fixed by the operator who has the largest mining and resource cost rather than by his neighbor who may be doubly favored with a mine less expensive to work and a lease less exacting in terms.

Confessedly, this analysis of the cost elements that enter into the price of coal emphasizes our lack of specific facts, which can be supplied in the future only through "installation of uniform cost-keeping methods and uniform and improved accounting systems," to quote from the declaration of purposes of the Pittsburgh coal producers. With the results of such bookkeeping in hand, more definite reply can be made to the public's appeal for relief from high prices. Yet even now it may be possible to suggest how that relief will eventually be obtained. Study of present conditions in the coal-mining districts fails to encourage the idea of governmental operation of the seven thousand coal mines in this country. More in line with the trend of public sentiment in the last decade, however, is governmental control in the interest of the consumer by regulation of prices, and to judge from the facts of experience in the regulation of transportation of other public utilities, the public coal commissions will be given sufficient discretionary powers to safeguard the interests of producer and consumer alike, and even mandatory requirements, either legislative or executive, will be subject to judicial review.

Competition seems to have failed of late years to benefit the consumer of coal. In the bituminous fields the competition, whenever present, has been wasteful and in the anthracite fields there has been practical absence of healthy competition, and whether too great or too little competition, the result is the same—to increase the actual cost of bituminous coal by saddling the industry and its product with the fixed charges on idle or semi-idle mines and to raise the price of anthracite coal by favoring the burdens of high resource costs.

In estimating the aggregate losses incurred by society by reason of the large number of mines not working at full capacity, the facts to be considered are that the capital invested in mine equipment asks a wage based on a year of 365 days of 24 hours, while labor's year averaged last year only 230 days in the anthracite mines and only 203 days in the bituminous mines, with only five to eight hours to the day.

As coal is more an interstate than intrastate commodity, any regulation of prices needs to be under federal control, and to benefit both consumer and producer such control can not stop with transportation and mining costs, but must stand ready to exercise full rights as a trustee of the people over the coal in the ground. The private owner of coal land, which derives its real value from society's needs, has no more sacred right to decide whether or not that coal shall be mined when it is needed by society or to fix an exorbitant price on this indispensable national resource than the coal operators have to combine for the purpose of exacting an excessive profit from the consumer, or the railroads to charge all that the traffic may bear. The proposal to bring landowner under the same rule as mine operator and coal carrier may seem radical, but where is the point at which coal becomes the resource upon which industrial society depends for its very life?

Public regulation, however, will be fair, and indeed in the long run will prove beneficial to the landowner as well as to the consumer, to the mine worker as well as to the operator, because any such agency as the

Federal Trade Commission, in its control of prices, must determine costs; and as we interpret the present attitude of the whole coal-mining industry the operators are willing to rest their case on a fair determination of actual costs on which their profits may then be figured.

Geo. Otis Smith,
C. E. Lesher

United States Geological Survey

JOSIAH ROYCE[1]

Josiah Royce died September 14, 1916, aged nearly sixty-one. He was born at Grass Valley, California, November 20, 1855. At sixteen he entered the University of California. There he came under the teaching of the geologist, Joseph LeConte, a pupil of Louis Agassiz; and this teaching Royce himself estimated as one of the greatest philosophical influences of his early life. There also he first became known to Daniel Coit Gilman, who was then the president of the university. Royce received his bachelor's degree in 1875, and left at once for a year of study in Leipzig and Göttingen. At the same time, Gilman was called to Baltimore to "launch" the Johns Hopkins University; and thither he summoned Royce to be one of the first twenty fellows on the opening of the new university in September, 1876. Two years later, in 1878, he received the doctorate at Baltimore, and then returned to Berkeley, where for four years he taught English and incidentally logic. In 1880 he married Katharine Head, and to her unfailing devotion and helpfulness the public acknowledgments of her husband's prefaces bear ample witness. In 1882, he was called to Harvard to fill a temporary vacancy occasioned by the absence of William James, and in 1885 he was appointed assistant professor. Not long after came a nervous breakdown so serious that he made the voyage to Australia in a sailing-vessel, and with happy result. In 1892 he was made professor, and in 1914, on the retirement of Professor Palmer, he became Alford professor of natural religion, moral philosophy and civil polity.

During his fruitful career as scholar and writer and teacher, he grew steadily in renown and influence. He was regarded with constantly deepening love by those who knew him, and with increasing admiration by the great company of those who read his books and heard his lectures. He received honorary degrees from Johns Hopkins, Aberdeen, Yale, St. Andrews, Harvard and Oxford. He was Ingersoll Lecturer at Harvard in 1899, and Walter Channing Cabot Fellow from 1911 to 1914. He was Gifford Lecturer at the University of Aberdeen, 1898 to 1900, and lecturer on the Hibbert Foundation at Manchester College, Oxford, 1913.

He died in the fullness of his intellectual powers, and with his fame still in the ascendant. During the last summer he heard of his election to an honorary fellowship in the British Academy. At the meeting of the American Philosophical Association, held in Philadelphia in December, 1915, he was honored as no American philosopher has been honored during his lifetime. Two sessions were devoted to papers concerning his philosophy and teaching (since published under the title "Papers in Honor of Josiah Royce on his Sixtieth Birthday"); and there was no member of the association who did not feel that he had a debt to acknowledge. Royce was able to receive such homage with the sincerest modesty and with a radiant kindliness and broadcast affection that made him loved even by those who never saw him except in public. He was a natural leader in any community of scholars, but his superiority, though it was masterly in quality, was both fatherly and brotherly in its feeling. During the last year of his life he was rarely able to forget the awful tragedy of the war. Many will feel that he reached the climax of his greatness when, at Tremont Temple on January 30, 1916, he became the inspired vehicle of a righteous indignation. His remarkable address, which at once made Royce a great public figure, is soon

[1] Minute on the life and services of Professor Royce placed upon the records of the faculty of arts and sciences, Harvard University, at the meeting of November 7, 1916.

to appear with other writings of his upon the war, under the title "The Hope of the Great Community." It is the last memorial of himself which his own hands fashioned and his own heart quickened.

Both the teaching and the writing of Royce testify to the extraordinary range of his attainments. Philosophy is wide, but Royce was wider. His prodigious memory, his powers of observation, and his linguistic versatility gave him a general equipment that few men of his day have possessed. In his earlier years he was a historian and a novelist. He was a wide reader and an acute critic of literature. He made permanent contributions to psychology. He was renowned as a moralist, and as a philosopher of religion. But during the later part of his life, logic and methodology became his favorite field of research. His eminence in this field, both as teacher and as writer, was not a little due to his remarkable grasp of mathematics and the physical sciences. Perhaps no man of his time knew so much about so many things and knew it so well. His knowledge of the special sciences was respected even by specialists. His most notable contribution to the teaching of the university was made through his seminary in logic, which became a veritable clearing-house of science. Men of widely different training and technique—chemists, physiologists, statisticians, pathologists, mathematicians—who could not understand one another, were here interpreted to one another by Royce, who understood them all. But he could do even more than that. He could interpret each man to himself, divine his half-thoughts and render them articulate.

Here is enough to make a great man. But to most persons, his peculiar metaphysics, known to many Harvard men as "Philosophy 9," and to thinking people everywhere through his volume entitled "The World and the Individual," will remain his principal monument. Royce's metaphysical thought was audaciously speculative; but to him speculation was the opposite of guesswork—it was a severe analysis of the certainties that lie at the basis of knowledge. When he asserted the existence of an all-comprehending mind, it was not as a probable hypothesis, but as a necessity of thought, implied in every act of judgment, even in our errors. Much of the fascination of his early work is due to his willingness to accept the weakest link in human intelligence as the support of the weightiest conclusions. His doctrine of reality as an absolute mind numbers him among the idealists in metaphysics. In the works which followed "The Conception of God," he was more inclined to express the nature of reality in terms of purpose than in terms of thought, and thus he came so far into agreement with the school of pragmatism. But since he regarded truth as dependent not on changing human interests, but on a single and eternal will, he distinguished his own doctrine as "absolute pragmatism." Royce was not one of those thinkers whose concern for the unity of existence obscures the sense of its pluralism and variety. "The World and the Individual" undertakes to determine the place of human personality in the life of the whole; and his solution finally embodied itself in his conception of the community. It is through loyalty to common causes that men must win both selfhood and freedom; and the goal of human endeavor is membership, through such loyalty, in the Great Community, which is the "city of God."

An estimate of Royce as an eminent man of science would be futile indeed unless coupled with some judgment as to the practical influence which his deep and subtile thinking had upon his own life and the life of his fellows. To him the great ultimate questions were not simply interesting scientific problems that challenged his intellect; they were also matters of intensely practical import for the spiritual quickening of his fellow-men. His personality, as it developed from that of the shy youth to that of the grave and gentle sexagenarian, was informed by a wideness of moral vision and a loftiness of moral standards that set him apart from the common. He could see the true values of things. This inspired and inspiring vision of the eternal realities enabled him not only to bear the severest blows of personal affliction with courage and serenity,

but also to awaken many a slumbering soul to a larger and nobler life. By precept and example he set forth worthy ideals of virile scholarship, of genuine religion, of civic, national and international righteousness. His spirit, reverent and fearless and tolerant, loving and loyal, still lives in his disciples. Who shall say when its workings will end? His place in the history of speculative philosophy is secure. He, being dead, yet speaketh, and we have no need to grieve. But in the fresh sorrow for our loss, we mourn for Royce as the man and the moulder of men.

THE SCIENTIFIC EXHIBIT OF THE NATIONAL ACADEMY OF SCIENCES

At the recent meeting of the National Academ of Sciences at Boston, there were arranged at the Massachusetts Institute of Technology, an interesting series of scientific exhibits, which were explained by the exhibitors in person. The exhibits were as follows:

H. S. White, Vassar College. Graphic representations of triad systems.

Frank Schlesinger, Allegheny Observatory, Allegheny, Pa. Photographs of Jupiter.

Miss A. J. Cannon, Harvard College Observatory. Stellar spectra.

Leon Campbell, Harvard College Observatory. Visual observations of variable stars.

Miss H. S. Leavitt, Harvard College Observatory. Photographic magnitudes.

Solon I. Bailey, Harvard College Observatory. Variable stars in clusters.

A. G. Webster, Clark University. Acoustical measuring apparatus: standard phone, phonometer and phonotrope. Application of a drop chronograph for use in ballistics.

Charles A. Kraus, Clark University. A new vacuum pump and a new thermostat.

H. P. Hollnagel, Massachusetts Institute of Technology. Methods of isolating the infra-red region of the spectrum.

Alexander McAdie, Blue Hill Observatory. Cloud studies, wind structure and snow flakes.

Ellsworth Huntington, Milton, Mass. The relation between solar changes and barometric gradients. Optimum temperature for the human race.

Robert DeC. Ward, Harvard University. Weather types of the United States, illustrated by composite weather maps and instrumental records.

R. A. Daly and H. Clark, Harvard University. Design for a deep-sea thermograph.

Frank Hall, Massachusetts Institute of Technology. A thermophone arranged so that direct comparison may be made with a magnetic receiver.

A. H. Gill, Massachusetts Institute of Technology. Tests of lubricating mineral oils.

F. G. Keyes and J. B. Dickson, Massachusetts Institute of Technology. Continuous flow calorimeter for measuring heats of reaction in solution.

C. L. Burdick, Massachusetts Institute of Technology. Determination of crystal structure by X-rays.

R. E. Wilson, Massachusetts Institute of Technology. Apparatus for maintaining pressures of one tenth micron or less, and the investigation of the mechanism of chemical reactions.

Henry Fay, Massachusetts Institute of Technology. Erosion of large guns.

Albert Sauveur, Massachusetts Institute of Technology and Harvard University: (1) Photomicrographic apparatus (original). (2) Photomicrographs of metals and alloys; charts and diagrams; specimens.

H. O. Hofman, Massachusetts Institute of Technology. (1) Jenny flotation machine. (2) A laboratory revolving horizontal roasting furnace heated electrically and rotated in the same way.

A. E. Kennelly and Associates, Massachusetts Institute of Technology. Researches in electrical engineering.

Alexander Klemin, Massachusetts Institute of Technology. Aeroplane models used in wind tunnel.

W. Lindgren and W. L. Whitehead, Massachusetts Institute of Technology. Photomicrographs of silver ores from Chile and Tintic.

C. H. Warren, Massachusetts Institute of Technology. (1) A graduated sphere for crystallographic work. (2) Photographs of spherulites in polarized light.

Charles Palache, Harvard University. Models showing gnomonic crystal projection.

Wallace W. Atwood, Harvard University. The former glaciers of the San Juan Mountains of Colorado. The physiographic stages in the evolution of the San Juan Mountains of Colorado.

J. B. Woodworth, Harvard University. Glacial map of Cape Cod and adjacent islands. A glypolith from Nantucket.

Laurence La Forge, U. S. Geological Survey. Recent topographic and geologic maps of New

England and other parts of the United States.

JOHN M. CLARKE, State Museum, Albany, N. Y. Portfolio of paleontological plates, in press. Plates of "Wild flowers of New York," in press. Geological map of Ogdensburg, N. Y., and vicinity, in press.

H. W. SHIMER, Massachusetts Institute of Technology. Evolution of some brachiopods.

RICHARD M. FIELD, Harvard University. Ordovician rocks and faunas of central Pennsylvania.

W. B. SCOTT, Princeton University. Proofs of plates for forthcoming report on paleontology of Patagonia.

W. J. V. OSTERHOUT, Harvard University. Pigments produced by the oxidation of a colorless plant chromogen.

CHARLES W. JOHNSON, Boston Society of Natural History. Distribution and variation of *Helix hortensis*.

JOSEPH A. CUSHMAN, Boston Society of Natural History. Some fossil and recent foraminifera.

ALFRED G. MAYER, Marine Laboratory, Carnegie Institution. Yacht and laboratory of the Carnegie Institution at Tortugas, Florida.

HUBERT LYMAN CLARK, Museum of Comparative Zoology, Harvard University. Echinoderms from Torres straits, Australia, with colored drawings and lithographs.

G. H. PARKER, Harvard University. The suction efficiency of a California sea-anemone.

W. T. BOVIE, Harvard University. Visible effects of Schumann rays on protoplasm. Effects of radium rays on permeability of protoplasm.

C. T. BRUES, Bussey Institution, Harvard University. Specimens and charts illustrating insects as carriers of infantile paralysis.

W. E. CASTLE, Bussey Institution, Harvard University. Examples of Mendelian inheritance, reversion and variety formation in rats and guinea-pigs.

FRANCIS G. BENEDICT, Nutrition Laboratory, Carnegie Institution. Respiration apparatus for animals.

T. B. OSBORNE, Connecticut Agricultural Station, and L. B. MENDEL, Sheffield Scientific School, Yale University. Photographs representing the growth of chickens fed with definite mixtures of food stuffs under laboratory conditions which have heretofore not led to success.

I. CHANDLER WALKER, Medical Service, Peter Bent Brigham Hospital. Proteid sensitization in relation to bronchial asthma.

H. S. WELLS, Medical Service, Peter Bent Brigham Hospital. Electrocardiography, or the application of the string galvanometer to the study of cardiac cases.

ALBERT A. GHOREYEB, Cancer Commission, Harvard University. Metal casts of heart and kidney blood vessels.

S. B. WOLBACH, Harvard Medical School. Studies in Rocky Mountain spotted fever.

HARVEY CUSHING AND W. M. BOOTHBY, Peter Bent Brigham Hospital. Apparatus of routine methods for clinical metabolism determinations.

E. W. GOODPASTURE, Peter Bent Brigham Hospital. An anatomical study of senescence, with especial reference to tumors.

E. E. TYZZER AND C. C. LITTLE, Harvard Medical School. The inheritance of susceptibility to transplanted tumor.

W. DUANE, Harvard Medical School. The technique of the preparation of radium for therapeutic purposes.

G. C. WHIPPLE, School for Health Officers, of Harvard University and Massachusetts Institute of Technology. Charts showing organization and membership of the school.

W. T. SEDGWICK, Massachusetts Institute of Technology. (1) Diagrams and tables illustrating the investigations of Professor Weston and Mr. Turner upon "The digestion of sewage effluents in an otherwise unpolluted stream." (2) An investigation of the behavior of certain species of bacteria in various materials between zero Centigrade and zero Fahrenheit. (3) A field investigation of the sanitary environment of a suburban population. (In room 10–411.)

S. C. PRESCOTT, Massachusetts Institute of Technology. Diseases of the banana in Central America and their control. (In room 10–411.)

ALFRED M. TOZZER, Peabody Museum, Harvard University. Race-mixture in Hawaii.

CHARLES PEABODY, Peabody Museum, Harvard University. Prehistoric specimens from caves of France and Palestine.

E. A. HOOTON, Peabody Museum, Harvard University. Casts and reconstruction of ancient man: skull of apes.

S. J. GUERNSEY, Peabody Museum, Harvard University. Cave explorations in northeastern Arizona.

ORIC BATES, Peabody Museum, Harvard University. Prehistoric Libyan remains.

THE NEW YORK MEETING OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE American Association for the Advancement of Science will hold its sixty-ninth meeting in New York City, from December 26 to December 30, 1916. This will be the fifteenth

of the convocation-week meetings and the first of the greater convocation-week meetings to be held hereafter once in four years, successively in New York, Chicago and Washington. When the association last met in New York, now ten years ago, there were about 5,000 members, the attendance was over 2,000, and there were nearly 1,000 papers on the programs. The membership of the association at present numbers about 11,000; the coming meeting will surely be the largest and most important gathering of scientific men hitherto held in this country or elsewhere. It has been planned that at these greater convocation-week meetings all the affiliated societies will join and this year there will be, including the sections of the association, more than fifty separate national bodies meeting together. Recent events have impressed on the general public the importance of science for modern civilization and national welfare and the responsibility of leadership has been placed on this country. It is consequently extremely desirable that scientific men make all possible efforts to be present at the meeting, which will be historic in the history of science and may serve in important ways to forward its advancement.

The registration headquarters will be at Earl Hall, Columbia University, and will be open on December 26, after 9 A.M. Most of the meetings of the sections of the association and of the national affiliated societies will be held at Columbia University. There will, however, be meetings at the American Museum of Natural History, at the City College, in the medical schools of the city and elsewhere, as may be arranged in the sections and by the societies. The council will meet at 9 o'clock on the morning of December 26, in the trustees' room, Columbia University, and will meet at the same time and at the same place daily during the meeting. The meeting of the general committee will be held at the hotel headquarters, the Hotel Belmont, at 9:30 on the evening of December 29. The Committee of One Hundred will meet at the Hotel Belmont at 2 o'clock on the afternoon of December 26. The several sections will hold their sessions for the nomination of officers and the transaction of other business on the call of the chairman, in most cases just before or just after the address of the retiring vice-president.

A complete program of the meeting, including the programs of the affiliated societies, will be ready on the morning of December 26 and will be given to members on registration. The reports on research work before the special societies will doubtless be more numerous than ever have been presented at a gathering of scientific men, and arrangements have been made for many programs of general interest and for social events, only part of which can be noted here.

The opening general session will be held at 8 o'clock on the evening of Tuesday, December 26, at the American Museum of Natural History. Dr. Charles R. Van Hise, president of the University of Wisconsin, will preside, and Dr. W. W. Campbell, director of the Lick Observatory, will give the address of the retiring president on "The Nebulæ." After the address there will be a reception by the president and the trustees of the museum.

Section A, Mathematics and Astronomy, will hold a general session, probably on Thursday. The address of Professor Armin O. Leuschner, of the University of California, will be on the "Derivation of Orbits." The American Mathematical Society, the Mathematical Association of America and the American Astronomical Society will meet in affiliation with the section.

Section B, Physics, will listen to the address of Professor Percival E. Lewis, of the University of California, on "Recent Progress on Spectroscopy," probably on Thursday evening. Papers in physics will be on the program of the American Physical Society, but there will be a general-interest session held jointly with Section C and the American Chemical Society. The Optical Society of America will meet in affiliation with the section.

Section C, Chemistry, will have as its vice-presidential address, "Asymmetric Syntheses and their Bearing upon the Doctrine of Vitalism," by Professor William McPherson, of the Ohio State University. Sections B and C, in conjunction with the American Chemical So-

ciety and the American Physical Society, will hold a joint session on "The Structure of Matter" on the morning and afternoon of Wednesday. These sessions will be held at the City College, which will provide luncheon and opportunity to inspect the buildings. On Thursday evening, at the American Museum of Natural History, Professor A. A. Noyes, of the Massachusetts Institute of Technology, will give one of the lectures complimentary to the citizens of the city on "The Production of Nitrogen." This lecture will be followed by a reception and a chemical exhibit. The American Electrochemical Society, as well as the American Chemical Society, will meet in affiliation with the section, and plans a symposium on "The Conduction of Electricity through Gases."

Section D, Engineering, will hold a session in the Engineering Societies Building, on the invitation of the United Engineering Society, the American Society of Civil Engineers, the American Institute of Mining Engineers, the American Society of Mechanical Engineers and the American Institute of Electrical Engineers. At this meeting Dr. Bion J. Arnold will give the address of the retiring chairman and there will be addresses by representatives of the engineering societies, followed by a reception to engineers and those working in sciences related to engineering. Section D will hold a joint session in the assembly hall of the Automobile Club of America, with the National Highways Association, the Automobile Club of America and the National Automobile Chamber of Commerce. There will also be joint sessions with the Society for the Promotion of Engineering Education and a session on sanitary engineering.

Section E, Geology and Geography, will meet on Tuesday and Wednesday, at Columbia University, when a special program by state geologists on the geology of their respective states will be presented. Owing to the death of Professor Charles S. Prosser, there will be no vice-presidential address. The Association of American Geographers will hold its meetings following those of the geologists. The address of the president, Professor Mark Jefferson, of the Michigan State Normal College, will be on "The Geographic Provinces of the United States." The American Alpine Club will meet at the New York Public Library on December 30.

Section F, Zoology, will hold its meetings with the American Society of Zoologists and the American Society of Naturalists. It is expected that Professor Vernon L. Kellogg, of Stanford University, will return from Europe in time to give the address of the retiring chairman. A dinner in honor of Professor E. B. Wilson, a past-president of the association, will be given at the Hotel Manhattan on Thursday evening, by his former students and colleagues. The Vertebrate Paleontologists will meet at the American Museum of Natural History on Thursday and Friday. The Entomological Society of America will meet on Tuesday and Wednesday, the address of the retiring president, Professor T. D. A. Cockerell, on "Fossil Insects," being given on the evening of the latter day. The American Association of Economic Entomologists will meet on Thursday, Friday and Saturday. There will be an address by the president, Dr. C. Gordon Hewitt, of the Dominion Experimental Farm at Ottawa. The entomologists will meet at Columbia University, with probably one session at the American Museum.

Section G, Botany, will hold a general-interest session on the afternoon of Wednesday, at which the address of Professor William A. Setchell, of the University of California, on "The Geographic Distribution of Modern Algæ," will be given. This will be followed by a symposium on the relations of chemistry to botany, opened by W. J. V. Osterhout and J. Arthur Harris. This is a joint session with the American Botanical Society, the American Phytopathological Society and the Ecological Society of America. Each of these societies will hold important programs. On Thursday there will be a joint session for the reading of invitation papers, at which the speakers will be William A. Murrill, Erwin F. Smith and W. A. Orton. In the evening a dinner for botanists will be given at the Hotel McAlpin, at which the address of Professor John M.

Coulter, the retiring president of the Botanical Society of America, on "Botany as a National Asset" will be given.

The American Society of Naturalists will meet on Friday. In the afternoon there will be a symposium on "Biology and National Existence," with papers by Stewart Paton, W. J. Spillman, Vernon L. Kellogg, Jacques Loeb and Edwin G. Conklin. After the dinner at the Hotel Manhattan in the evening Professor Raymond Pearl, of the Maine Experiment Station, will give the presidential address. The New York Zoological Society will entertain at the New York Aquarium the members of the Society of Naturalists and related societies on the evening of December 27. The American Eugenics Association will meet on Tuesday, Wednesday and Thursday, the address of the president, Dr. David Fairchild, of the United States Department of Agriculture, being on "The Importance of Photographs in Presenting Eugenic Discoveries." The Eugenics Research Association will hold a meeting under the presidency of Dr. Adolf Meyer, of the Johns Hopkins University.

Section H, Anthropology and Psychology, will refer special papers to the American Anthropological Association and the American Psychological Association. The address of the retiring chairman, Professor Lillien J. Martin, of Stanford University, will be on "Personality as revealed by the Content of Images." The American Anthropological Association, under the presidency of Dr. F. W. Hodge, of the Bureau of American Ethnology, will meet at the American Museum of Natural History, on Tuesday, Wednesday, Thursday and Friday. In affiliation with it will meet the American Folk Lore Society, the address of whose president, Dr. Robert H. Lowie, of the American Museum of Natural History, will be on "Oral Tradition and History." The American Psychological Association celebrates the twenty-fifth anniversary of its foundation on the afternoon of Friday. There will be historical papers by G. Stanley Hall, J. McKeen Cattell, Joseph Jastrow and John Dewey. The address of the president, Professor Raymond Dodge, of Wesleyan University, on "The Laws of Relative Fatigue," will be given on Wednesday evening at Columbia University, followed by a smoker. The annual dinner will be at the Hotel Marseilles. The association will hold a joint session with the section of education on Friday. The American Philosophical Association will meet at the Union Theological Seminary, adjacent to Columbia University, on December 26, 27 and 28. The address of the president will be given by Professor A. O. Lovejoy, Johns Hopkins University.

Section I, Economic Science, will listen to an address on "Scientific Efficiency and Industrial Museums, our Safeguards in Peace and War," by Dr. George F. Kunz, of New York. The programs of the section will be devoted to the metric system, to the national thrift movement, and to the effect of peace on our economical conditions. These sessions will be held at Columbia University. There will be a meeting concerning insurance on Friday afternoon in the Metropolitan Auditorium, Madison Square.

Section K, Physiology and Experimental Medicine, will meet at the American Museum of Natural History on Friday afternoon. Professor Frederic P. Gay, of the University of California, will make an address on "Specialists and Research in Medical Science" and there will be a symposium on "Cancer and its Control," taken part in by Gary N. Calkins, Leo Loeb, J. C. Bloodgood, James Ewing and E. C. Lakeman. This will be a joint meeting with the American Society of Bacteriologists. The Federation of American Societies for Experimental Biology, consisting of the American Physiological Society, the American Society of Biological Chemists, the American Society for Pharmacology and Experimental Therapeutics, and the American Society for Experimental Pathology will meet at the Cornell Medical College on Thursday, Friday and Saturday. There will be dinners on Thursday and Friday evening. The American Association of Anatomists will hold its meetings on Wednesday, Thursday and Friday, in the anatomical laboratories of three medical schools of the city, under the presidency of Professor Henry H. Donaldson, of the Wistar Institute.

Dr. Simon Flexner, director of the laboratories of the Rockefeller Institute for Medical Research, will give one of the public lectures before the association.

Section L, Education, will have, as the vice-presidential address, "Some Obstacles to Educational Progress," by Professor Ellwood G. Cubberley, of Stanford University. The section will meet on Wednesday, Thursday and Friday for discussion on educational tests and measurements, research problems and administrative problems. The American Nature Study Society and the School Garden Association of America are among the societies meeting with the association. The Society of Sigma Xi will hold its annual convention at Columbia University on the afternoon of Wednesday, with its dinner in the evening, at which there will be an address by the president, Dr. Charles S. Howe, president of the Case School of Applied Science. The American Association of University Professors will meet at Columbia University on Friday and Saturday, with a dinner at the Hotel Astor on Friday evening.

Section M, Agriculture, will meet on Tuesday and Wednesday. The address of the retiring vice-president, Dean Eugene Davenport, of the University of Illinois, will be on "The Outlook for Agricultural Science." This address, which will be delivered on the afternoon of December 27, will be followed by a symposium on the same subject, which will be taken part in by H. J. Wheeler, J. C. Lipman, G. F. Warren and B. Youngblood.

There will be a scientific exhibit and conversazione in University Hall, Columbia University, on the afternoons of Wednesday, Thursday and Friday, from twelve to six and probably on Wednesday evening from eight to ten. The demonstrations and exhibits before the separate societies will be made as usual, but in addition there will be gathered in one place exhibits showing the more important recent advances in the sciences in so far as they are of general interest. Scientific men will be present from four to six in the afternoon to explain and demonstrate the exhibits. It is hoped that the conversazione will not only be a convenient way for scientific men to inspect the work being done in different sciences, but will also enable them to meet their colleagues working in other departments.

Tea will be served by the Columbia University Ladies Committee in the Philosophical Building from four to six on the afternoons of Tuesday, Wednesday, Thursday and Friday. The Faculty Club of Columbia University will be open to men as a social center at these and at other times. The courtesies of the Chemists' Club (52 East 41st Street) are extended to members (men) for the days of the meeting. The Alumni Clubs of different universities and colleges and the Fraternity Houses, of which there are large numbers in New York City, will doubtless be glad to welcome their alumni. Luncheons may be obtained in the Columbia University Commons, the lunch room of Horace Mann School and the lunch room of Barnard College and in restaurants adjacent to the university.

The hotel headquarters will be the Hotel Belmont, which allows a discount to members on all rooms. It is situated opposite the Grand Central Station on 42d Street. This is also an express station of the subway by which Columbia University (Broadway and 116th St.) can be reached in about twelve minutes. The cars are marked Broadway or Dyckman Street; Lenox Avenue and Bronx Park cars are to be avoided. Other hotels have been selected as headquarters for some of the societies and sections. Thus the naturalists have selected the Manhattan; the zoologists the Astor; the botanists the McAlpin; the entomologists the Endicott; the anatomists the Martinique and the psychologists the Marseilles. Reservation of rooms should be made well in advance, as New York hotels are often completely full at this season of the year. The dormitories of Columbia University (for a limited number of men) and the dormitories of Barnard College and of Teachers College (for women) will be open for members at a cost of $1 a night. There are numerous boarding and lodging houses in the neighborhood of Columbia University which at the time of the meet-

ing will not be occupied by students and can be engaged by members.

The announcements here made are only those that have been reported well in advance and represent a small part of the programs. More than one thousand papers and addresses will be presented at the meeting, which will represent fully the advances of the natural, exact and applied sciences during the past year. There will, indeed, be so many simultaneous programs of interest that the difficulty will be to choose among them. A meeting of this size, however, will be held only once in four years, and the conflict is after all not so serious as if the meetings were held in different cities. A joint meeting of scientific men working in all fields gives opportunity for them to meet personally and to consult through committees and boards on means of promoting the advance of science by joint action. A meeting of such magnitude also serves to impress on the general public the strength which science has attained in this country, and the need of supporting scientific research for the welfare of the nation.

SCIENTIFIC NOTES AND NEWS

The John Fritz medal was awarded in January, 1916, to Dr. Elihu Thomson, for "Achievements in Electrical Inventions, in Electrical Engineering, in Industrial Development and in Scientific Research." We learn from the *Electrical World* that the medal will be presented to Dr. Thomson at a meeting to be held in Boston on Friday evening, December 8. The presentation will take place in the Central Lecture Hall of the new buildings of the Massachusetts Institute of Technology. The program of the evening will include addresses by John J. Carty, chairman of the presentation committee of the board of award; E. W. Rice, Jr., president of the General Electric Company, and Dr. Richard C. Maclaurin, president of the Massachusetts Institute of Technology. The presentation will be made by Dr. Charles Warren Hunt, and the ceremonies will conclude with the response of Dr. Thomson. The John Fritz medal is awarded from time to time for notable scientific or industrial achievement, and was provided for in a fund subscribed in memory of the great engineering pioneer, John Fritz. The award of the medal is made by a permanent board composed of four members from each of four American national engineering societies, namely, the American Society of Civil Engineers, the American Society of Mechanical Engineers, the American Institute of Mining Engineers and the American Institute of Electrical Engineers. The members of the 1916 board are: Representing the civil engineers—Charles Warren Hunt, John A. Ockerson, George F. Swain, Charles D. Marx; representing the mechanical engineers—John R. Freeman, Ambrose Swasey, John A. Brashear, Frederick R. Hutton; representing the mining engineers—Albert Sauveur, E. Gybbon Spilsbury, Charles F. Rand, Christopher R. Corning; representing the electrical engineers—Ralph D. Mershon, C. O. Mailloux, Paul M. Lincoln, John J. Carty.

The trustees of Cornell University have accepted the resignation of George Sylvanus Moler, professor of physics, to take effect in June, 1917. Professor Moler will retire from teaching, having reached the age limit. The board placed upon its minutes the following resolution:

Resolved, that the trustees in accepting the resignation of Professor Moler desire to express their high appreciation of his faithful and devoted service to the university in the department of physics for over forty years. As a teacher he is held in affectionate and grateful remembrance by many generations of university students. For twelve years he shared with Professor Anthony the entire work of the department and during that period in collaboration with him designed, constructed and installed the first dynamo in America, the first arc-lighting system (that on the campus of Cornell University), and the first apparatus for the electrolytic production on a considerable scale of oxygen and hydrogen. He has also devised countless original and ingenious pieces of apparatus of incalculable value to the department of physics. And the photographic laboratory in Rockefeller Hall, with its original and unique equipment, is largely of his planning.

DR. R. A. MILLIKAN, professor of physics in the University of Chicago, has been appointed Hitchcock lecturer at the University of California for 1917, and will give a series of lectures at Berkeley, beginning about February 1. Among the Hitchcock lecturers of recent years at the University of California have been Thomas Hunt Morgan, professor of zoology in Columbia University; Henry Fairfield Osborn, research professor of zoology in Columbia University; Dr. A. D. Waller, director of the physical laboratory of the University of London; Julius Steiglitz, professor of chemistry in the University of Chicago; Harry Fielding Reid, professor of dynamical geology and geography in the Johns Hopkins University, and Dr. Richard M. Pearce, professor of research medicine in the University of Pennsylvania.

DR. FRANK D. ADAMS, Logan professor of geology and dean of the faculty of applied science, McGill University, has just completed a course of six lectures on pre-Cambrian stratigraphy for the department of geology, Columbia University.

DR. CARLOS CHAGAS, of the Institute for Experimental Pathology at Rio de Janeiro, has been invited to conduct a course on tropical medicine at Harvard University.

THE vice-chancellor of Cambridge University has appointed Mr. R. T. Glazebrook, C.B., fellow of Trinity College, director of the National Physical Laboratory, to the office of reader on Sir Robert Rede's foundation for the ensuing year.

AT a recent general meeting of the members of the Royal Institution, Dr. H. E. Armstrong, F.R.S., was elected a manager, in place of the late Professor Sylvanus P. Thompson. A resolution of condolence with the relatives of the late Sir Victor Horsley, a member of the Royal Institution, was passed.

A CORRESPONDENT informs us that Dr. H. B. Fantham, of the Liverpool School of Tropical Medicine, who was appointed to the post of chief protozoologist to the forces of the Allies at Salonika, has been seriously ill with amœbic dysentery and is at present convalescing—but on duty—at Malta.

WE learn from *Nature* that Major T. Edgeworth David, professor of geology in the University of Sydney, has recovered from the effects of serious injuries received while conducting mining operations in northern France, and hopes shortly to rejoin his regiment.

PROFESSOR G. CAREY FOSTER, a past president of the Institution of Electrical Engineers, has been elected by the council an honorary member of the institution.

AFTER forty-five years' service Dr. C. Ritsema, keeper of the entomological collections of the State Museum of Natural History at Leyden, has retired. He is succeeded by R. van Eecke.

DR. WM. H. WESTON has resigned his position as instructor in biology in charge of the botanical work at Western Reserve University to accept a position as a pathological inspector of the Federal Horticultural Board. He will be stationed at Washington, D. C.

DR. ERIC MJOBERG, a Swedish explorer, who arrived in New York on November 22, said, as reported in daily papers, he had come to the United States to study the latest inventions in aviation preparatory to making arrangements for an exploration trip into the interior of New Guinea.

AT the meeting of the Section of Medical History of the College of Physicians of Philadelphia, on November 21, Dr. Arnold C. Klebs, Washington, D. C., read a paper on "Some Recent Results of Paleopathologic Research."

DR. J. PAUL GOODE, professor of geography at the University of Chicago, recently gave a lecture before the Civic and Commerce Association of Minneapolis on the "Geographic and Economic Foundation of the Great War."

AT the two hundred and twenty-sixth meeting of the Elisha Mitchell Scientific Society, held at the University of North Carolina on November 14, the papers were: Dr. W. C. Coker, "Some Problems in Classification"; Mr. T. F. Hickerson, "The Quebec Bridge."

THE municipal and university authorities of Barcelona recently placed a marble memorial

tablet on the house at Castellersol where had been born Dr. M. Fargas Roca, professor of obstetrics and gynecology at the University of Barcelona, and senator of the realm. After this ceremony the procession passed to the city hall, where his portrait was installed.

Dr. Francis J. Keany, trustee of the Boston City Hospital, and professor of dermatology at Tufts Medical School, died on November 23, at the age of fifty years.

Dr. Henry Gunder, formerly professor of mathematics at Findlay College, Ohio, and later at Little Rock University, Arkansas, died on November 20, at the age of seventy-nine years.

James S. Duff, of Toronto, minister of agriculture for Ontario, died on November 17, at the age of sixty years.

Dr. Oskar Backlund, the eminent director of the Imperial Observatory at Pulkova, Russia, died on August 29. He was in his seventy-first year and had been the director of the Pulkova Observatory since 1893.

Emeritus Professor John Ferguson, who last year resigned the regius chair of chemistry in the University of Glasgow, which he had held since 1874, died on November 3, aged seventy-nine years. In addition to his work in chemistry he was a well-known archeologist.

Professor H. M. Waynforth, professor of engineering, King's College, University of London, died on November 5, at the age of forty-nine years.

Professor H. H. W. Pearson, professor of botany in the South African College, died at Mount Royal Hospital, Wynberg, on November 3. The London *Times* says: "His death is a great loss to botanical science, in which he had a European reputation, particularly by his discovery of missing links in evolutionary botany. His death is felt with peculiar intensity in South Africa, where Mr. Pearson's professional enthusiasm and keen perception of scientific possibilities were mainly responsible for the establishment a few years ago of the Kirstenbosch Botanic Gardens, which on the testimony of the director of Kew is likely to become one of the most valuable, economically and scientifically, in the world."

Nature reports the death of Lance-Corporal J. W. Hart, who, having volunteered in the early days of the war, was killed on September 15. At the beginning of the war he held the post of horticultural assistant at Bedford College, London, and was in charge of the botanical garden, the successful development of which was largely due to his skill and energy. The death is also reported of Lieutenant John Handyside, who fell in one of the recent advances on the Somme, at the age of thirty-five; he was a distinguished graduate of Edinburgh and Oxford, and since 1912 had been lecturer in philosophy in the University of Liverpool.

A clipping sent us from a Munich newspaper reads: "Dr. Oskar Piloty, professor of chemistry at Munich, son of the distinguished painter, lost his eldest son in battle. In order to avenge his death, the father of his own accord joined the army in France, and he too has now been killed."

After conference with many of the vertebrate and invertebrate paleontologists in different parts of the country it has been deemed wise for the vertebrate paleontologists to meet in the State Museum, Albany, Wednesday, December 27 in company with the geologists and invertebrate paleontologists. On Thursday and Friday, December 28 and 29, an adjourned meeting of the Vertebrate Paleontologists will be held in the American Museum of Natural History, New York, at hours to be announced later. Members are invited to send immediately titles of papers or discussions directly to Dr. W. D. Matthew, acting secretary of the Vertebrate Paleontological Section. Arrangements will be made for a reunion dinner on Friday evening, December 29.

The Association of American Agricultural Colleges and Experiment Stations met at the new Willard Hotel, Washington, D. C., on November 15, 16 and 17.

The fifteenth anniversary of the Ohio Society of Mechanical, Electrical and Steam Engineers was celebrated in its thirty-fourth meeting, which was held on the campus of the

Ohio State University, November 16. Among the speakers were Professor Horace Judd and Professor F. W. Marquis, both of the department of mechanical engineering of this university.

The Electrical World states that this year America's Electrical Week will be inaugurated by the first permanent flood-lighting of the Statue of Liberty on the evening of December 2. President Wilson and a distinguished gathering of diplomats and industrial leaders will officiate at a program of ceremonies starting in lower New York harbor and concluding at a banquet to the nation's executive in the Waldorf-Astoria Hotel. Mayor Mitchel, of New York City, has named a committee of some two hundred representative men in the electrical industry and in business and civic life, who will escort President Wilson and his party during the inaugural. A committee on arrangement has charge of an electric vehicle parade starting from the Battery and passing up Broadway to Lafayette Street, over Fifth Avenue to the Waldorf-Astoria Hotel. The official ceremony of rededicating the statue will take place at the Waldorf-Astoria Hotel. Ambassador Jusserand, who will present a special message from the President of France, and ex-Senator Chauncey M. Depew, who delivered the main oration of the statue thirty years ago on October 28, will deliver orations, to which it is expected the President will reply briefly.

A government investigation of industrial fatigue by physiologic methods has just been made by Dr. Stanley Kent, the physiologist, and is summarized in the *Journal of the American Medical Association*. The report is divided into three sections. The first deals with fatigue as a result of overtime. It is stated that when the week-end rest is suspended, fatigue will persist; residual fatigue resulting from inadequate rest leads to lowered efficiency and lessened output. Overtime periods worked on consecutive days produce more fatigue than if separated by days of ordinary length. Overtime induces more fatigue late in the week than it does early in the week. Overtime is physiologically and economically extravagant. It frequently fails in achieving its object, as the following case shows: A girl in one of the works frequently did not attend during overtime. She also habitually began work at 8:30 instead of 6 A.M. Thus she usually worked only eight hours a day, instead of twelve. When asked the reason, she replied that the extra rest enabled her to work so much more quickly that she was able easily to make up for the lost time. The second section of the report deals with the influence of fatigue and of overtime on output. The total daily output may be diminished by the introduction of overtime, for the rate of working and total output are limited by fatigue rather than by other conditions. A group of piece workers increased their earnings considerably as a result of a diminution in the length of the working day. In the third section it is stated that the total output of a factory is a question of adjustment of the factors concerned, the principal of these being the actual time worked and the actual rate of working. Reduction of the latter will soon counterbalance increase of the former, and thus overtime frequently leads to a diminution of total output. The health of the worker, on which his rate of working and his endurance depends, is prejudiced by overtime and to a less extent by work in the early morning hours. The suspension of overtime was followed in every case by an improvement in conditions of the worker, and was found to effect a saving of 4.5 per cent. The experiments on which the foregoing conclusions are based were carried out with great care and by means of all kinds of ingenious apparatus for testing attention and working power. Both male and female labor was employed in the factories concerned. Dr. Kent also points out that the evidence is against Sunday labor, which is liable to prove "disastrous." As a result, the minister of munitions has stopped all Sunday work in the factories producing munitions.

In a lecture before the Royal Society of Arts on November 3, Professor William Stirling, of the University of Manchester, said that the insatiable demand for shells, guns and other munitions of war had made the problem of industrial fatigue suddenly acute. The problem to be solved, and it was being solved,

was to ensure the maximum of output with the minimum of fatigue. Overtime was an elastic term, and not only imposed a severe strain on the worker, but it curtailed unduly the periods for rest and repose; it was uneconomical, physiologically extravagant, and frequently resulted in lost time and diminished output.

UNIVERSITY AND EDUCATIONAL NEWS

The University of Chicago has received from Mr. Frederick H. Rawson a gift of $300,000 for the construction of a laboratory building in connection with the plans for the medical school.

A provisional gift of $100,000 to the University of Vermont has been given by General Rush C. Hawkins, of New York. The money is given on condition that the university raise an additional $200,000.

Tulane University has received a bequest of $60,000 for the School of Tropical Medicine, available after the decease of the wife of the late Colonel W. G. Vincent.

The new gymnasium of the Stevens Institute of Technology was dedicated with appropriate ceremonies on November 18. The building, which was erected at a cost of over $125,000, is the gift of Mr. William Hall Walker, of New York.

Dr. L. V. Heilbrun has been appointed instructor in microscopic anatomy at the College of Medicine at the University of Illinois.

The School of Medicine of the University of Alabama announces that two new all-time professors have been appointed to the faculty. Dr. Joseph M. Thüringer, of the Harvard Medical School, becomes head of the department of anatomy, and Dr. Claude W. Mitchell, Ph.D. (Nebraska, '13), M.D. (Chicago, '15), head of the department of physiology and pharmacology.

Mr. William George Palmer, B.A., formerly scholar, has been elected to a fellowship at St. John's College, Cambridge. Mr. Palmer, who came up from Guildford Grammar School, took a first in each part of the Natural Science Tripos, 1913–14, with distinction in chemistry, and was awarded the Hutchinson studentship.

DISCUSSION AND CORRESPONDENCE

SYNCHRONISM IN THE RHYTHMIC ACTIVITIES OF ANIMALS

Two men walking together keep step so easily that the keeping step seems automatic. With a similar feeling of its naturalness we keep time in various ways, as in marching or dancing to music. Although these actions seem so automatic, they all or nearly all were learned by conceptual awareness of the relations between one's own actions and the actions of others, and purposive imitation of the latter. Such awareness of relations and purposeful imitation have not been found in animals (with the possible exception of the Primates). Certainly in most of the behavior of animals the tendency to keep time with an external rhythm is conspicuously absent. When two horses are driven abreast, each trots in his own rhythm in sublime disregard of his team-mate. Every circus has its so-called dancing animals, but I never saw one that really kept time with the music except as the trainer prompted it. Some birds have wonderful musical powers, but I never knew of a case of two birds singing in unison, nor of a bird singing synchronously with any external rhythm.

Nevertheless, although an animal can not have a concept of the relation between two coinciding rhythms, it is supposable that some animals might have an innate mechanism that would bring them into synchronism with an external rhythm, just as two pendulums or two dynamos, if properly adjusted, maintain a perfect synchronism. Let us review the observations that might substantiate such a supposition.

Many animals are provided with lock and key reflexes which produce an admirable synchronism. Two cocks fighting jump at each other at almost the same moment. Many birds, notably some of the Limicolæ, fly in close flocks and the whole flock turn apparently at the same moment in their rapid evolutions. But it is important to notice that these actions are not rhythmical. To maintain such admirable synchronism and at the

same time maintain a rhythm would be a quite different task.

There are some cases in which animals do act in synchronism with an external rhythm, but so far as I have observed they are always cases in which the time of the animal's actions is regulated by a powerful force from the environment, and fall under one of the two following heads: (1) Slow rhythms, such as those of the seasons, or of day and night, in which there are changes in temperature, light, etc., which have plenty of time to act on the organism; (2) cases in which there is bodily contact between the organism and that with which it keeps in synchronism, as the case of a canary swinging on a swing-perch, or that of certain spiders swinging on their webs. Are there any cases which do not fall under either of these two heads? Some observers have reported them, but let us examine their reports.

Dr. Edward S. Morse[1] cites a case from memory in which he saw "fireflies flashing in unison," but he gives no exact details. He quotes a paper by Mr. Blair[2] mentioning the same phenomenon; but Mr. Blair states that he never observed the synchronism himself, and he does not cite any authority who has observed it. Dr. Morse in another paper[3] quotes R. Shelford as observing a tree full of fireflies pulsating "so that at one moment the tree would be one blaze of light, whilst at another *the light would be dim and uncertain.*"[4] This last clause makes it appear that some fireflies were not in synchronism with the others, and thus brings in the statistical fallacy to be mentioned presently. Dr. Morse quotes Dr. H. C. Bumpus as another observer of the phenomenon; I wrote to Dr. Bumpus, asking certain questions, and he kindly sent me the following statements as to his observation: he saw the synchronism in perhaps 50 fireflies distributed over two acres; he noticed the synchronism only as he was passing the area, so can not say how long it lasted; the interval between flashes was perhaps a half second; he thinks the synchronism was not accidental and not an illusion; but he thinks there were also *some fireflies that were flashing asynchronously.*[4] Now, where a large number of fireflies are flashing at slightly differing rates there must be a great amount of accidental synchronism; to determine whether there is a degree of synchronism not due to mere accident, one would need a statistical examination. Viewing any large assortment of instances without statistical methods, one can see in them whatever one is predisposed to see; and we are always predisposed to perceive a rhythm—this is a well-known psychological fact. I once had an experience which I think was like that with the fireflies: I was looking at a great area of water covered with ripples flashing in the sunlight, and the flashes I saw were all synchronous, at a rate of perhaps three per second; but their synchronism must have been an illusion.

Dr. Morse[5] quotes a different case, from Cox, who says:

> Certain ants . . . when alarmed, knock their heads against the leaves and dead sticks . . . every member of the community makes the necessary movement at the same time.

This case would seem to necessitate that the ants perceive time relations, for each ant must know when the sound is to come and must anticipate it by making the head movement. It is much more probable that the synchronism was an illusion of the observer.

Professor W. B. Barrows[6] reports seeing a bittern sway gently from side to side as the grass around it was swayed by the wind. But it is doubtful if the observer, seeing the bird against a moving background, could tell truly whether it swayed or not. The details which are given make the phenomenon seem very like an illusion.

In 1897, Dolbear[7] stated that all the crickets in a given field chirp simultaneously. But

[1] Morse, E. S., SCIENCE, February 4, 1916, 169–170.

[2] Blair, K. G., *Nature*, December 9, 1915, 414.

[3] Morse, E. S., SCIENCE, September 15, 1916, 387–388.

[4] Italics mine.

[5] Morse, E. S., *loc. cit.*, 387.

[6] Barrows, W. B., *The Auk*, April, 1913, 187–190.

[7] Dolbear, A. E., *American Naturalist*, Vol. 31, 970–971.

Professor Shull[8] observed more carefully, found that this was not the case, and concluded that the synchronism observed by Dolbear was an illusion. However, Shull observed certain cases in which two individuals were in synchronism. His observations are not open to the objections raised in case of the fireflies, because: first, there being only two crickets concerned, the statistical fallacy does not enter; secondly, his observations were repeated and checked with great care, the rate of chirping being accurately timed. There can be no doubt that Shull observed real synchronism between two crickets at a time. But he says (in a letter to me, dated October 8, 1916):

> I am at present inclined to think that these cases of synchronism were usually accidental. . . . However, the insects do, I am sure, influence one another. . . . I regard it as still an open question whether something more than chance was involved.

In the article quoted, he questions whether the synchronism may have been due merely to temperature; for at a given temperature nearly all the crickets chirp at almost exactly the same rate.

In answer to our question whether animals ever do maintain a synchronic rhythm of a sort not included under (1) and (2) of my fourth paragraph, we have found good evidence for an affirmative answer only in the case of crickets chirping. And in that case it is still somewhat in doubt whether their simultaneity is accidental, or due to the influence of environment, or due to a lock and key adaptation by which one cricket stimulates the other. If any naturalist can give complete and accurate observations on such synchronic rhythms, these will be of great interest to the psychologist.

WALLACE CRAIG

UNIVERSITY OF MAINE

IS CUCUMBER MOSAIC CARRIED BY SEED?

IN 1915 cucumber mosaic caused a rather serious loss on one of the farms where cold frame cucumbers are grown in the tidewater section of Virginia. The same disease again developed on this farm in the spring of 1916 on land which was in cucumbers last year and also on land which had not grown this crop for the past three years. This year as usual the seed was sown in pots in the greenhouse and the plants were transplanted to the cold frames on April 5, 1916.

On May 25, 1916, before the glass covering had been removed from the cold frames, the writer observed typical mosaic plants scattered throughout the frames. A little later "white pickle" fruits were also obtained from the diseased vines. Of a total of 7,785 plants 110 were diseased on the above date.

The cold frame growers in this section all use one strain of forcing-cucumber seed which they obtain from the same seed company. On visiting the other cold frame farms during the same week typical cases of mosaic were found on three of the five farms and plants suspected of the disease were observed on the other two. Plants on one of the latter two farms have since produced typical "white pickle" fruits though the leaves are not strikingly mottled.

These observations indicated that the disease was carried by the seed, but as in some cases the diseased plants were growing on land which had produced mosaic plants the previous season, there remained the possibility of a soil factor.

Data which made the matter of soil transmission appear less likely was obtained from cucumber plants which the writer was growing at the Virginia Truck Experiment Station. These plants were from the same strain of seed as that used by all of the cold frame growers. The seed was planted April 27, 1916, in a cold frame of steam sterilized soil which had not previously grown a crop of cucumbers. Of a total of 155 plants 58 typical mosaic plants were observed on June 5, 1916. No insects were observed on the plants up to that time, probably due to the fact that the bed is surrounded on three sides by a tall hedge and on the fourth side by the station greenhouses. The high percentage of diseased plants and the failure to account for the disease in any other way lead the writer to think that this mosaic came from the seed.

[8] Shull, A. F., The Stridulation of the Snowy Tree-cricket (*Œcanthus niveus*), *Canadian Entomologist*, 1907, Vol. 39, 213–225.

Further confirmatory data relative to seed transmission has since been obtained from seed which the writer saved from typical "white pickle" cucumbers collected during the season of 1915. Unfortunately a large per cent. of the seed thus obtained was destroyed by mice. From the small amount which remained eleven typical mosaic plants have been obtained. These plants first showed mosaic in the second or third true leaves, and have since produced typical "white pickle" fruits. The plants were started in pots of steam sterilized soil and transplanted to a field which had not previously grown cucumbers. At the time the disease was first observed on these plants no cucurbits were growing nearby and no insects had been seen on the plants. It seems advisable to present these observations as indicating another means of primary dissemination of cucumber mosaic.

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THE CULTURE OF PRE-COLUMBIAN AMERICA

To the Editor of Science: In common doubtless with many of your readers I noted with interest the short sketch by Professor Grafton Elliot Smith of his views regarding the migration of culture to the American continent. I also awaited with some expectation of assurance an unveiled hostility, which has now appeared in your columns of the issue of October 13, under the signature of Dr. Goldenweiser and Mr. Means.

From the nature of circumstances it must be some weeks before my former chief can reply to these gentlemen and I would request, therefore, in the meantime the opportunity to make a few suggestions.

Apart altogether from the confession of Dr. Goldenweiser, it is of course obvious from their arguments that both writers have arisen in opposition and committed themselves in your columns without having informed themselves of Professor Elliot Smith's precise statements and method of handling his mass of accumulated evidence.

From a somewhat misleading footnote in your issue of August 11 it would seem that "The Significance of the Geographical Distribution of the Practise of Mummification" had as yet to be published. This monograph appeared in the *Memoirs* of the Manchester Literary and Philosophic Society on July 7, 1915, and was published in book form under title "The Migrations of Culture" a few weeks later. But together with the succession of ensuing papers in that journal and in the *John Rylands Bulletin,* this important monograph seems entirely to have escaped the attention of your contributors. That this should be so in the maze of present-day literature is entirely forgivable, but it is amazing that in "awaiting with the greatest interest and impatience" further exposition of Elliot Smith's brilliant work, ethnologists should hasten with such unseemly speed to warn him against encroaching upon a theory which by the assertion of Dr. Goldenweiser himself must forever rest upon the uncertain basis of mere negative evidence, a theory which to some of us in the light of modern exactitude of method seems scarcely defensible.

Dr. Goldenweiser would have us prove every step of the way in the diffusion theory, and rightly so. In the chaos of ethnological observations, many of them afforded by amateur or untrained investigators, and by indifferent methods, too much stress can not be laid upon this. But at the same time are we really to accept for any particular custom the assertion of independent development merely because as yet rigorous proof of diffusion is not forthcoming! Professor Elliot Smith simply contends that we should subject both to the most searching investigation. Contrary to Dr. Goldenweiser's suggestion, it is not loosely claimed that sometime, somehow, diffusion has occurred. Such statements as have been made are accompanied by tangible evidence of their accuracy. The excellent and indisputable researches of Professor G. A. Reisner and Dr. Elliot Smith in Egyptian archeology afford a striking example of the care and vigor with which every shred of evidence is scrutinized. In the work of the two investigators just mentioned on the discovery of the use of copper and the evolution of the rock cut tomb and in

the distribution of these arts the same searching technique is perceptible and the complete reconstruction of the historic event which Dr. Goldenweiser justly demands is already forthcoming. Especially is it to be observed that this is the case in the assertion of independent development in Egypt of both these practises, a proof, the possibility of which Dr. Goldenweiser apparently denies. But indeed if, as on Dr. Goldenweiser's own statement, all the proof that we have is in favor of diffusion, may we not at least with equal right transpose one of his sentences and say, "In all cases diffusion must be assumed until independent development is proved or, at least, made overwhelmingly probable"?

If such striking similarities, parallelisms, convergences in the working of the human mind really do occur, why, in the words of Mr. Means, should there be no such thing as a wheeled vehicle in all pre-Columbian America? Mr. Means's difficulties over wheels and ships are precisely those which the supporters of independent development should hasten to explain. As a matter of fact, as most recently Dr. Rivers has demonstrated, it is the useful art which frequently is lost in the spread of culture. The human mind is not the logically working instrument, leaping at once to full conception of the connection between cause and effect, between possibility and use, which we are invited to assume. In the geographical distribution of culture whatever has been merely useful tends to disappear; whatever is bound to the consciousness of the individual through some link of superstition or religion tends to be retained, though its significance may be misunderstood or indeed even reversed.

It is true, as Mr. Means hints, that so far no comprehensive and detailed analysis has been made of the physical anthropology of the American peoples comparable with that undertaken by Professor Elliot Smith and his associates upon the ancient Egyptians. It is to be hoped that we may be able to make the lack good in time. But the impress left upon the features and the impetus given to the arts and crafts alike of the ancient Egyptians by the immigration of alien peoples leads me to suspect that in the bodies of the pre-Columbian Americans themselves we may ultimately find the corroborative evidence of whence American culture came. It may well be that by this method we shall find the arrows in Dr. Elliot Smith's figure correctly placed. But even if, as in fact Professor Elliot Smith believes, inherent difficulties in the work will prevent physical anthropological studies in America from bearing the conclusive results obtained from similar researches in Egypt, the case for diffusion, contrary to Mr. Means's conception, is not thereby weakened. In the sturdy nature of its composition the culture-complex is amply strong enough to stand by itself and the possibility that some avenues of approach are closed to us does not necessarily prevent our arrival at definite conclusions along those which are plainly open. Critical ethnologists will, I am sure, judge from the facts themselves.

In conclusion, like one of your contributors, I await with impatience a further monograph from Professor Elliot Smith's fascinating and compelling pen; a monograph which I hear from other sources is to be entitled "The Ancient Mariners."

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MOSQUITOES AND MAN AGAIN

Without continuing the discussion further than the limits of this paper, it seems advisable to state once more the contention made in my paper "Mosquitoes and Man"[1] for Mr. Jennings in his rather elaborate and erudite criticism[2] of it misses the whole point so completely as to be definitely surprising and almost amusing.

The point was not the "association" of mosquitoes with man, but that the malarial mosquito *followed* man, and while following man is included in the association with man, it is nevertheless a specific point and worthy of some attention.

1 Science, June 2, 1916.
2 Science, August 11, 1916.

Major Ashburn's observations were, that in a given place, men and mosquitoes being associated, on the removal of the human element the malarial mosquitoes no longer bred in that locality as before, the larvæ from being numerous became rare, almost, if not quite absent. An instance of this occurred at Miraflores, formerly a hot-bed of malaria, and where *Anopheles albimanus* bred in abundance. When, in connection with the Canal work, the inhabitants were removed, it was presently discovered that although the breeding conditions were quite as good, *A. albimanus* was no longer breeding in that locality as before, the larvæ having become *very* rare. Contrariwise, that when camps were established in new localities where malarial mosquitoes and their larvæ were rare or unknown, both adults and larvæ presently appeared in greatly increased numbers, and this was followed by a malarial outbreak among the men. Major Ashburn has records of some ninety instances where these conditions, in connection with the establishment and abandonment of construction camps, occurred, and it was on this large number of cases that he based his conclusions.

The question of an "animal barrier" is not a question of whether any given mosquito will attack a horse or a cow or a dog, but whether such animals will prove a protective barrier, against the malarial mosquitoes, for human beings living beyond. Whether disease-bearing mosquitoes will breed except near human habitations is another question, and apparently has several factors, so that it is quite possible that it can not be answered by a general statement. However it is quite certain that these mosquitoes would not have become "disease-bearing" if they had not bred near habitations and been in close touch with man.

The experience of many sanitarians has been that, under usual conditions, to keep the breeding places of malarial carriers at a distance of "four hundred yards" is sufficient to protect the inhabitants of a locality from malaria, and Watson shows that the outer coolie lines are at least the only ones attacked under these conditions. This can only mean that the malarial mosquitoes do actually breed near, and not, as Mr. Jennings suggests, "at a distance from human habitations." Also of course this implies the intimate association of malarial mosquitoes and man, and there is nothing in my paper to indicate a lack of recognition of that general condition. It called attention to an entirely new viewpoint, and one that gives a valid reason not only for the usually accepted limit of flight, but to Dr. Watson's observations concerning the outer coolie lines, and even for the long flight recorded at Ancon, while it suggests a hitherto little recognized need of the protection of human beings in the formation of new camps in heretofore uninhabited sections where no malaria has been known, or where the larvæ of malarial mosquitoes are extremely rare or unknown.

It is hardly permissible to assume ignorance, on the part of a Medical Officer and a worker in preventive medicine, of the literature and labors of many investigators whose work was based on the, at least implied, "association" of mosquitoes and man. Even the average layman knows the story of Manson's suggestion to Ross. Especially is such an assumption out of place in regard to Major Ashburn, whose work on the transmission of disease by insects, carried on in the Philippines as a member of the "Board for the Study of Tropical Diseases" is widely known and accepted as one of the authorities on the subject.

It is always better to keep "an open mind" on every subject, scientific or otherwise, and certainly to avoid unfair comments on other workers. There is work enough for all, and the various phases of the study of disease are so complicated as to give every part of the subject many sides, and many points of contact with the labors of special investigators in other branches. That the whole may develop in a well-balanced and scientifically correct fashion requires harmonious interrelation between these various workers, and a just recognition of the viewpoints of others. Mr. Jennings's connection with the work in the investigations in the Canal Zone should have broad-

ened him sufficiently to have made other attitude and action impossible. C. S. LUDLOW

ARMY MEDICAL MUSEUM,
WASHINGTON, D. C.,
September 29, 1916

THE SONG OF FOWLER'S TOAD (BUFO FOWLERI PUTNAM)

IN SCIENCE for September 29, Mr. H. A. Allard states that for some years he has heard at Clarendon, Va., two types of toad cries. One was uttered early in the spring, "a steady, trilling monotone," lasting "from 10 to 20 seconds," and "resembling the song of *Bufo americanus* as it is heard in New England." The other was that of Fowler's toad, "the unmistakable, weird, wailing scream which advertises its presence throughout its range." He further states that on May 2, 1916, he caught toads uttering the former note, and found them to be *Bufo fowleri*. He presented them to the National Museum, where they are under accession number 59692.

Now I have collected for some years in the region in question, as my home is in Alexandria, and I have found both *B. fowleri* and *B. americanus* fairly common, although *fowleri* seems the more abundant. I have studied the breeding habits of these toads at Haverford, Pa., where both occur very commonly and are quite distinct.

Americanus is one of the first Anura to appear in the spring; *fowleri* one of the last. Transformed *americanus* are sometimes met with before *fowleri* begins to sing. The note of *fowleri* there is always the short snoring scream. The note of *americanus* is always much longer, although its trill and its softness are somewhat dependent on whether the toad is on land or in the water. I have collected *fowleri* in numbers at Brevard, N. C., at an altitude of 2,200 feet. The note there was the same which I have heard at Alexandria and at Haverford.

Finally, during the first part of September, I was working in the reptile and amphibian department of the National Museum, and while looking over the catalogue I chanced to see there an entry of *B. fowleri* with the remark that the note was that of *B. americanus*. My interest aroused by this and also by the fact that they were local specimens, I looked them up and examined them. I soon came to the conclusion that they were not *fowleri* at all, but *americanus*. They were much too large for *fowleri*, and they had large warts arranged singly in spots as in *B. americanus*, instead of the small warts, three to five in a spot as in *B. fowleri*. These toads were catalogue number 59692, and were collected by Mr. Allard at Vinson Station, Va., on May 2, 1916. Mr. Allard was probably misled by the fact that they did not have the deeply spotted breast of most *americanus*, but this is not too reliable a character, as some *B. fowleri* have speckled breasts and some *B. americanus* have, as in this instance, immaculate breasts.

Thus there is no reason to believe that Fowler's toad has two distinct notes, and confidence can still be reposed in the calls of toads and frogs as differentiating characters.

E. R. DUNN

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SCIENTIFIC BOOKS

Morphology of Invertebrate Types. By ALEXANDER PETRUNKEVITCH. The Macmillan Company, New York. 1916.

Under this title Professor Petrunkevitch offers us a laboratory guide for representative invertebrate types and, in addition, material of the sort commonly found in our textbooks. "Each chapter consists of two parts: a monograph in which a description is given of the animal selected as representative of its class and instructions for the students to follow in dissection." The purpose of the former is to give the student an account of the morphology of his type form to which he may refer throughout his dissection and to give the teacher more freedom, since the lectures are thus relieved of much detail. The book is frankly morphological, as its name implies, and the author makes no apology for this; but rather contends in his preface that the student who aspires to the work of experimental zoology is often hampered by "a superficial knowledge of the structure, life and development of those very animals which in his later studies

he is going to use for experiments." The book is written not for the elementary course in invertebrate zoology, which is sometimes offered as a part or the whole of a course in general zoology, but for third and fourth year undergraduates who are presumed to have completed one or more courses in zoology. It is the outcome of a course in which its author attempts to give students, who desire more zoology either from general or professional interest, a foundational knowledge of invertebrate morphology, and very wisely he makes no attempt to overload a large subject with the many other interesting facts by which we often think to re-clothe the dead bones—or in this case perhaps one should say shells—of morphology. The types included are as follows: *Paramœcium, Grantia, Pennaria, Sertularia, Tima, Gonionemus, Aurelia, Metridium, Dendrocœlum, Dicrocœlium, Tænia, Ascaris, Lumbricus, Nereis, Hirudo, Daphnia, Homarus, Schistocerca, Agelena, Asterias, Ophiopholis, Pentacrinus, Arbacia, Thyone, Venus, Limax, Loligo* and *Molgula.* This list is comprehensive and probably represents as much work as can be accomplished in the time allotted to a course of this nature. Other forms are promised, if the sales warrant a subsequent edition. From the morphological standpoint, this list is excellent and the reviewer would only suggest that the addition of another Gastropod, preferably *Helix,* of notes on the fresh-water mussel and of something further upon the Entomostraca would be of value. The presence of the fluke *Dicrocœlium lanceatum* in the list is an innovation which will doubtless be welcome to American zoologists, since it is so highly recommended; though the reviewer has found a fluke from the frog's lung, which he identifies as of the genus *Hæmatolœchus,* extremely satisfactory when properly fixed and stained. The very complete account of the spider *Agelena nævia* is a valuable addition, as the arachnids have often received scant attention, and reflects the author's familiarity with this class of invertebrates. In a paragraph entitled "Material," which appears at the beginning of each chapter, there is given a brief statement of the specimens and preparations needed for the work outlined and of the author's methods of technique. This information is valuable and in a number of instances, such as the use of a leaf in the killing of *Dendrocœlum lacteum* mentioned on page 55 and the method of preparing *Tænia,* page 72, the reviewer notes methods with which his experience in invertebrate zoology has not made him familiar.

The distinctive feature of the volume is the elimination of explanations and interrogations from the *Instructions* and the inclusion of all such matter in the *Descriptive Part* which is a morphological monograph of the form under discussion. The "instructions" are reduced to such a degree that those for the simpler forms and the sections of those for more complex forms covering any one day's work might almost be written out in full on a blackboard of moderate size. There is no attempt to put the student through his paces or teach the method of induction through the medium of the laboratory instructions. Such brief directions demand rather more of the instructor, but the plan is a good one with students of the class for whom the book has been written, as the reviewer knows from having once or twice tried a similar scheme in his own classes. In looking through these instructions one gains an impression that there are some drawings suggested which are too difficult for any one without pronounced artistic ability, as, for example, the figure of the mouth parts of the lobster mentioned on page 137, and there is perhaps a tendency toward more isolated figures and fewer larger and more comprehensive ones. This statement, however, represents an impression which might not be justified after the actual use of the book in the laboratory. As a matter for special commendation, the author of this review notes the procedure outlined for the dissection of *Molgula,* which can be recommended since it is essentially like a method which has been developed in my own laboratory after some disappointment at the failure of students to master what seemed an easy matter.

The figures are few in number, but in the main good. Those of the Nematode on pages

80 and 82 and the longitudinal section of the lobster on page 129 are obscure and need to be redrawn with a view to clearness and perspective. The old Parker & Haswell figure of Anodonta which appears on page 209 has been through the mill of text-books in the past twenty years and looks it. By comparison with its appearance in the original edition of the work from which it was taken it presents a sorry spectacle and it is time such a plate went to the scrap-heap. In Figs. 28 and 31, the explanations are written at the ends of label lines and not below with reference letters or abbreviations on the figures. Without criticism of the present work, we may ask why this practise is not more common. The time required for reference is distinctly less and the eye work not so much of an effort in the examination of a figure so labeled. The great majority of the figures in this volume might have been labeled by writing the words in full at the ends of the label lines, and when we come to recognize the importance of every little saving in eye strain this is one of the reforms which will be effected.

It is stated in the preface that "the student is expected to read the descriptive part at home, the day before" and thus to prepare himself for the laboratory exercise. The reviewer objects to this on pedagogical grounds because in his experience one of the least profitable things a student can do is to read accounts of things he has not yet seen when it is possible for him to see them first and particularly when he is to see them next day. Although quite familiar with most of the forms included in this volume, the reader will find it something of an effort to picture to himself the morphology of the animal in question, and what must it be to the student who has never seen the inside of a starfish or a squid. Can he really do otherwise than create at some labor a mental picture which he will find incorrect the next day and which might have been simply and correctly formed if such a morphological account had followed rather than preceded his study of a given form. The experience of one of my old teachers, who once remarked that for twenty years he had tried to understand *Nautilus* from accounts in published papers and always thought of it as a form with structures most difficult to understand, comes to mind. At last by chance he obtained a specimen which he was able to dissect for himself, and then he wondered at its simplicity and thought how few difficulties the animal would present to one beginning with the actual specimen. In a work like the present volume, the individual instructor is left free to use the monographic parts in any relation to the laboratory work he may choose and the writer believes that, as a matter of economy and efficiency in learning, the student should use these accounts at the same time or subsequent to the laboratory study, for it is very difficult to understand such matters in advance where the figures are so few. The only difficulty in the way of such use of the present volume is the brevity of the instructions, which are, of course, written with reference to the monographic accounts; but there should be no difficulty in the student's using the two together as he works in the laboratory, since both are in one volume. We should not object to reading in the laboratory save that it can also be done elsewhere, and it would be a fortunate thing if we could make the laboratory more a place of quiet study both of animals and of books than one for an altogether mechanical process of dissection and drawing. My suggestion for the efficient use of such a book would be that the student read the monographic parts as he needs them in the laboratory and again with great thoroughness in reviewing his work and when his completed drawings may serve as illustrations; though for my own purposes I prefer a less complete separation of "instructions" and "explanations."

Other points which had been jotted down in reading for this review appear now of such a minor nature that to mention them might seem like petty criticism. The book is well done, clear, concise and to the point and shows a mastery of invertebrate morphology which may be envied. It is not a work which gives the impression of having been carelessly put together. Whatever criticisms one may have, it should be remembered that it is for the

use of older students who will have their own ways of working, and the very brevity of the laboratory instructions allows greater latitude for both student and teacher. The older courses in invertebrate zoology are being crowded in these days when zoology has developed so much of interest, but some of us have always insisted that it is preposterous for a man to go into zoological work without at least as much knowledge of invertebrate morphology as is set forth in this volume and a man should get this as an undergraduate. Students who have other scientific interests or whose interest in zoology has no direct relation to their subsequent work may well elect, after an introductory study, other courses in preference to this; but for the young zoologist such a knowledge of morphology is a foundation stone, and perhaps our author has produced a volume that will be more lasting because it makes no attempt to modernize the invertebrate course, but offers it on an exclusively morphological basis, leaving the other things to the newer courses in ecology and parasitology and field zoology which are already in our midst.

In behalf of the publishers it may be said that the typographical work is up to their usual standard and the surface and quality of the paper ideal for a work of this nature.

WINTERTON C. CURTIS

CAPTAIN WHITE'S RECENT EXPLORATORY WORK IN AUSTRALIA

FOR several years past I have corresponded regularly with that most indefatigable explorer of certain unknown regions in Australia —Captain S. A. White, of Adelaide. Captain White, who is a member of many scientific societies and institutions, resides upon his elegant estate at Fulham, South Australia, and almost every year, in one capacity or another, he becomes connected with expeditions that explore the entirely unknown regions of the far northwest parts of the Australian continent. On these trips he is accompanied by his wife, who cheerfully shares her husband's trials and dangers, and she is more than entitled to her quota of the glory and credit of their common discoveries. No fewer than fourteen of these hazardous trips have been made—some of them lasting many months—the travelers pressing their way into the most remote and unexplored districts of this great island continent. Upon the return of the expedition, Captain White usually publishes their discoveries in some of the scientific journals, such as the *Transactions of the Royal Society of South Australia;* but in addition to these accounts he gets out popular ones in booklet form, and he has kindly presented me with several of these, covering some of the more important expeditions. The last one of these is now before me; and, as its recorded results, discoveries and contributions to science are so remarkable, I am sure that no apology is required for making a brief notice of them here.

This, the fourteenth excursion of the kind, was made during 1914, the start having been made about the middle of June. On this occasion Captain White officially represented the Royal Society of South Australia and the Royal Geographical Society of Australia as the associated naturalist, and he was fully equipped for the most varied duties pertaining to that part of the work. Mr. G. M. Mathews, F.R.S.E., the distinguished ornithologist of Australia, accompanied them, with other noted individuals, the party as a whole being a large one. Baggage and collecting material of all kinds was packed on camels, sixteen of these valuable animals forming a part of the expedition, which, for this particular year, was known as the "Geological Survey Expedition." It started at the terminus of the railroad on June 17, 1914, at a place called Oodnadatta, with all hands well and everything in fine shape. After reaching the Alberga River, it followed this stream more or less closely for a long distance, and then made direct for the Everard range of mountains, where considerable collecting and survey work was accomplished. Skirting the foothills, it returned to Moorilyanno N. Well, and took a side route to examine Indulkana Spur and neighboring territory. The route then led to the Musgrave ranges far beyond, the expedition being subjected to terrible hardships on

account of the heat, the drought that prevailed, lack of water, and similar causes.

Captain White's booklet of 200 pages is a day-to-day record of the entire history of this expedition, with a detailed account of its achievements for science. He took many valuable photographs of natives, animals, botanical specimens and localities, and not a few of these have been reproduced to illustrate the little volume, while a map of the route traversed is inserted opposite the preface. Many of the mammals, birds and other forms of life are described in great detail, and in the most lucid and interesting manner. A great part of this must necessarily be omitted from the brief notice I am now writing, and the space allowed me given over only to a reference to the more important discoveries and results achieved by the party. Among the first successes scored was the rediscovery of John Gould's long-lost bird, *Aphelocephala pectoralis,* formerly *Xerophila pectoralis,* a single specimen having been taken in 1871 and lost shortly thereafter. Several specimens were obtained by Captain White and his most efficient collector, Mr. J. P. Rogers. On one page he writes, about six or seven days after the start:

> A little after noon we reached one of Mr. Breaden's wells near Murdaruma, on the Woldridge Creek, where the camels were watered and we had some lunch. One of those tragedies which are so often enacted in the far-back country came under our notice. A bait had been laid for wild dogs, and a fine dingo had been successfully poisoned; but, unfortunately, a party of wedge-tailed eagles had attacked the carcass of the dog, the result being that some of these fine birds lay dead around, the great wings stretched out (they are the largest eagles in the world) over the ground in their last agonies, others were sitting round, unable to escape, due to the paralyzing effect of the poison (p. 16).

All the scientific members of the expedition became much excited as it approached the Musgrave range, for scarcely anything was known of the flora and fauna there, and footprints of the "wild men" had already been discovered by the camel drivers. Almost at once a new plant was collected, and it has since been named by Mr. Black *Foxanthes whitei.* The weather was cold, and the water-bags froze hard during the night. There is a fine description given of Glen Ferdinand, and of some of the remarkable birds found in the surrounding region. Among these may be mentioned the rare blue-vented parrot (*Neopsephoatus burkii*), the crested pigeons (*Ocyphaps lophotes*), the white-fronted honey-eaters (*Ramsayornis albifrons*), and the curious little buff-throated grass-wren (*Diaphorillas t. purnelli*), a most extraordinary species both in coloration and in habits.

Some of the species of ants met with are described in detail by Captain White, and the description of their nests and their ways makes a most interesting chapter, not to say a very remarkable one.

Some of the boulders and rocks and walls of the great caverns had strange pictographs upon them, drawn there by some unknown natives; there were other evidences of the latter's existence.

In due time the expedition returned to the Everard ranges; the main one was entered and the signs of the existence of natives became more abundant. Footprints were fresh, and every one felt that these strange people would soon be met with in their own little-known land. Soon they were heard giving signal calls, which a native with the expedition answered as best he could, for he was not of their tribe. Finally a dozen or so of them put in an appearance. Captain White says:

> They were all armed with two or three spears of the single-barb variety, which they called "ooruta," a yam stick, "wanar," and they also carried a long-shaped wooden bowl, "mera," which is used for carrying food, for scooping out the sandy soil when hunting for food, and for many other uses. They did not wear covering of any kind. A single or double strand of hair string encircled their waists, and their chests were covered with red ochre, with a circle of white down from the wedge-tailed eagle, extending from one armpit down to the lower part of the chest and up to the other armpit; the down is stuck to the skin by means of human blood. They were mostly young men, and their hair was bound into a chignon shape, which stood out, in some cases, over a

foot behind and was decorated with hawk's feathers (p. 76).

As these natives followed along with the expedition for a number of days, Captain White was afforded the opportunity to study not a few of their habits and customs; indeed, before this exploratory excursion drew to a close, he not only was the discoverer of an entirely new tribe, but he contributed a mass of ethnological and anthropological knowledge to what we formerly knew of the native tribes. This was not only new, but also of great importance, especially in view of the fact that these black men are now gradually being eliminated by the whites, and will soon become utterly extinct. Miscegenation with respect to the two races practically amounts to nil; moreover, the native women, as in the cases of other low races, are usually nonfertile in such crossing.

The women of this tribe never wear clothing of any kind, and Captain White's photographs of them exhibit those he succeeded in obtaining entirely nude. They have great affection for their children, and are much pleased when strangers pay them any attention. The peculiar ceremonies of this tribe are described by our intrepid explorer with very considerable detail, and among other things he remarks:

> The dry watercourse before mentioned still traversing our line of march, we were at times passing over its loose, sandy beds, with a row of redgums (which lined the watercourse) on either side. A native would give forth a sharp exclamation while looking up into one of the gumtrees. Then, in the twinkling of an eye, half a dozen natives would be up that tree, their lithe, muscular and naked forms moving from branch to branch with the ease of apes. They were in search of the large white grubs, or larvæ, of a well-known moth, which passes the first part of its existence boring in the gum wood. These grubs are much sought after by the natives, who call them "margoo." It is wonderful how they can tell at a glance if the grub is at home, and how well they can make a hole in the gum wood with a sharp-pointed stick hardened by fire! When the search was over, down they would come again to mother earth with a grunt, and on the march again. Not an item of anything missed these happy children of the desert. They would try to show me a bird, a reptile or an insect at a distance when the object was stationary; and after several minutes of vain attempts to show me where it was, the object would move off; if I showed my vexation, they would laugh softly and pass remarks among themselves. Tracks, which these wild men saw at a glance as they walked along, the sight expressed only by a nasal "hem, hem" and the outspreading of the fingers, or the pointing in a certain direction with the index one, were not revealed to me, when, on hands and knees, I was peering into the spot where the track, to my dusky companions, was easily seen; and when I rose with a shake of the head, they only quietly laughed and passed on, wondering, no doubt, at the slow-witted white man.

Captain White found but few mammals in the country traversed, and snakes, too, were rare. Upon the other hand, quite a number of new birds were taken, and the specimens brought back with the party. In fact, ninety-four species of birds were collected, five of which were new. Many undescribed insects were found in the stomachs of the small birds brought back, and the main collection of spiders and insects contained a great many more entirely new forms. New moths and ants were also taken, the latter being worked up by Professor W. M. Wheeler, of Harvard University. Professor Wheeler found nineteen species of ants new to science. Five new plants were found in the two hundred species collected, one of which was a heretofore undescribed species of tobacco.

Another expedition will soon be organized; doubtless many more novelties will be discovered, and more exhaustive studies made of the rapidly disappearing natives.

R. W. SHUFELDT

WASHINGTON, D. C.,
September 14, 1916

SPECIAL ARTICLES

THE OVULATION PERIOD IN RATS

THERE are many observations on the occurrence of ovulation in mammals; but very few investigations on the regular recurrence of that event, perhaps because of the fact that such investigation must involve the systematic study of sections of whole ovaries and oviducts of animals killed at frequent intervals over

a considerable period of time. This has been done by Leo Loeb for the guinea-pig. For the rat there are no published observations except those by Kirkham and Burr (1913), from which it is to be inferred that the ovarian cycle has a length of twenty-one days.

Although further studies on the rat are being carried on by the senior author, it seems worth while at this time to present in outline the chief conclusions arrived at, reserving for a later paper a more complete presentation and discussion of evidence.

The most obvious and certain evidence of the occurrence of ovulation is the presence of eggs in the oviduct. It is chiefly upon this kind of evidence that the conclusions are based. There is also a further source of information concerning the ovarian cycle in the corpora lutea, formed in most cases from the ripe follicles which have discharged their eggs. The corpora lutea grow and undergo such changes before degenerating that there may be as many as 40 in one ovary, of which only the youngest and oldest can sometimes be identified with certainty. However, the newest corpora up to an age of about $2\frac{1}{2}$ days can be distinguished from older ones. Such young corpora are always present when eggs are in the oviduct, and their absence when no eggs exist in the tubes is additional proof that ovulation either has not occurred (especially if the ovary contains large follicles), or took place several days before.

All of the 80 females used were isolated from males before their last litters were born, and thereafter were kept alone or with other females. Also their young were at once removed, usually before being suckled.

The ovaries and oviducts were sectioned, the position of the eggs (when present) in the oviduct was determined, and the condition of the corpora lutea noted. The animals were killed at intervals during 101 days after parturition, 67 of the 80 rats being taken during the first four 10-day periods as follows:

1	to	9 days,	18 rats
10	"	19 "	15 "
20	"	29 "	17 "
30	"	39 "	12 "
40	"	42 "	5 "

making an almost complete series at one-day intervals. They are grouped at still closer intervals about the tenth, twentieth, thirtieth and fortieth days. The rest of the animals were killed only at about ten-day intervals from 50 to 101 days.

Unfertilized eggs pass through the oviduct in about three days, usually having degenerated by the end of that time, as determined by a study of 15 animals killed during the first four days post partum. Accordingly the distance traveled by the eggs in the oviduct is of importance and was taken into account in estimating the time of ovulation.

Of the 80 animals examined 49 revealed eggs in the oviduct. To these may be added 14 more in which it is permissible to estimate the time of ovulation. Summarized they are as follows:

Ovulating after Parturition

Rats	Days	Average
15	$\frac{3}{4}$– 1	
11	$9\frac{1}{2}$– 13	11
1	$15\frac{1}{4}$	
13	19 – $23\frac{1}{2}$	20
1	$24\frac{1}{2}$	
5	$27\frac{3}{4}$– $34\frac{1}{2}$	$30\frac{1}{4}$
5	38 – $41\frac{1}{2}$	$39\frac{1}{2}$
2	$49\frac{1}{2}$– 50	50
2	$57\frac{1}{2}$– $58\frac{1}{4}$	58
2	$67\frac{3}{4}$– $70\frac{1}{4}$	69
2	78 – 82	80
2	87 – $89\frac{1}{2}$	89
2	$97\frac{3}{4}$–101	99

Of the other 17 rats none had eggs in the oviduct, and the ovaries presented no evidence of recent ovulations. They were killed between the periods enumerated above.

The foregoing indicates that female rats when kept isolated from males ovulate on the average every 10 days.

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OVULATION IN MICE

It has been known since the time of Tafani (1889) that mice normally ovulate soon after giving birth to litters. According to Sobotta (1895) a second ovulation takes place in

nursing mothers on an average 21 days after parturition, a discovery he made use of in his study of maturation. There are no other printed records of spontaneous ovulations in addition to that coming immediately after parturition.

The following is a summary of the results, with respect to the occurrence of ovulation, of an investigation, still under way, of the ovarian cycle in mice. The study is being carried on in the same way as for rats outlined in the preceding article.

Sixty-two female mice of various coat colors were bred, allowed to have their litters when isolated from males, kept alone or with other females, and killed at intervals during a period of 91 days. Most (52) were killed during the first 56 days at intervals of about 2 days, except between 18 and 21 days, 34 and 38, and 50 and 56 days when the interval was a day or less. The rest of the animals were taken between 70 and 74½, and 87½ and 91 days.

The sections of the ovaries and oviducts were examined for eggs in the oviduct and for the youngest corpora lutea. In determining the time of ovulation the position of the eggs in the oviduct was considered; and the presence or absence of the youngest corpora lutea was used as a check.

The examination of these mice indicated that the second ovulation occurred at from 15 to 19 days following parturition, the third at about 35, the fifth at 69 to 72, and the sixth at 87 to 90. No ovulation was found at the expected fourth, perhaps because too few animals were killed at that time. But it is significant that of those animals killed at 70 to 74, and 87 to 91 days which fall within the expected later ovulation periods, 3 and 2 animals were found to have ovulated at the sixth and seventh periods respectively; also that none of the mice killed between the ovulation periods was found to have ovulated.

It thus appears that the normal ovulation period in mice recurs at about 17½ to 18 days.

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AGAR AGAR FOR BACTERIOLOGICAL USE

Agar agar is used by so many, as a basis of nutrient media, that any suggestion as to how to select the most suitable grade is worthy of consideration.

Fellers[1] has recently published some bacteriological studies on agar agar. The same author[2] has also prepared a paper on the composition of agar agar and given methods for purifying commercial agar. No matter how easy the method proposed for the purification of a substance is, we have to select that which we intend to purify. One of the best ways of determining the stability of an organic substance is to find out how much it will be hydrolyzed under the conditions it is to be used. Hydrolysis is, generally, increased with temperature, and thus increased acidity at high temperatures is often due to greater hydrolysis at the high temperatures. If substances show an increased acidity at high temperatures, but when cooled back to normal temperatures return to the acidity they had before the heating, the high temperatures have not materially changed their composition. Some samples of agar agar have been known to develop a large increased permanent acidity due to autoclaving. It is evident that such samples should not be used for accurate work. The increased acidity due to autoclaving and due to titration made in hot solutions can be made use of in selecting agar agar for laboratory use.

The following described test has been found to designate the superiority of some samples of agar agar over others. Samples chosen by means of this test are always those which go completely in solution when heated with carbon dioxide free distilled water. Further media made with them have a lower acidity than media made with agars not so good by the test.

THE TEST

The test depends on the increase in acidity of water solutions of the agar due to autoclaving and to titrations made near 100° C.

[1] Fellers, *Soil Science*, Vol. II., No. 3, p. 255.

[2] Fellers, *Jour. Ind. and Eng. Chem.* (Article to appear soon.)

Several samples of agar each claimed to be the best that some commercial house has in stock are secured. Powdered and shredded agar are used alike. The shreds are cut up into half-inch lengths, so that aliquots may be more representative. (An ordinary print trimmer makes a very satisfactory agar cutter.) As many 500 c.c. Erlenmeyer flasks (Jena, pyrex or non-sol glass) as there are samples to be tested are cleaned, dried and weighed to within 0.1 gm. 4.5 gm. of agar agar are put in each flask and enough carbon dioxide free distilled water added to make the contents of the flask up to 300 gm. The flasks are shaken and put in a bath containing boiling water. They are shaken at intervals to aid solution of the agar. When the agar has dissolved the flasks are removed and contents brought up to original weight with hot carbon dioxide free distilled water.

25 gm. aliquots of the agar solutions thus prepared are weighed out in triplicate into 350 c.c. Erlenmeyer flasks (Jena, pyrex or non-sol glass) which have just been rinsed with hot carbon dioxide free distilled water. The triplicates for each sample are designated for convenience *A, B, C*—thus those from sample No. 1 would be 1*A*, 1*B* and 1*C*.

To each *A* flask is added approximately 250 c.c. of hot carbon dioxide free distilled water. The flasks are shaken until the contents appear homogeneous. They are stoppered and set to one side until they attain room temperature.

The *B* and *C* flasks are tightly stoppered by cotton plugs and autoclaved for 15 minutes under 15 pounds pressure. After autoclaving about 250 c.c. hot carbon dioxide free distilled water is added to the *B* and *C* flasks. The *B* flasks are restoppered and left to cool to room temperature. The *C* flasks are set on a steam bath. When the contents of the *C* flasks are up to 95° C. or above, they are removed individually and titrated at once with $N/10$ or $N/20$ carbon dioxide free alkali. One drop of a 1 per cent. phenolpthalein solution is used as the indicator. The titration is finished when the faintest discernible, yet permanent, pink color appears. The *A* and *B* flasks are titrated in the same manner after they have cooled to room temperature.

CURRENT YEAR'S TEST OF AGAR AGARS

Seven samples of agar agar were secured in answer to letters to five concerns. Five samples were shredded agar, one a powdered agar and one, "Bacto Agar." Sample No. 1 in the table is the powdered agar and No. 4 is "Bacto Agar."

All samples were uniform, clean and bright, except No. 5, which was darker, dirty and ununiform.

TABLE I

Acidity of Agar Agar Solutions and Nitrogen Content of Agars Used

No.	Titrated R. T.,[3] NA.	Titrated R. T., A.	Increase due to A.	Titrated H., A.	Nitrogen in Agar
1	.060% (a)	.040%	−.020%	.100%	.27%
2	.040	.080	+.040	.120	−(1)
3	.040	.060	+.020	.140	.31
4	.040	.060	+.020	.088	.31
5	.052	.080	+.028	.142	.16
6	.036	.032	−.004	.076	.27
7	.044	.052	+.008	.100	.27

THE TABLE SHOWS

1. That the maximum variation in acidity between samples of agar agar when titrated at room temperatures is only .024 per cent. before autoclaving, but is doubled by autoclaving.

2. Titrating the autoclaved aliquots when hot accentuates the differences between samples, the maximum variation being greater than the greatest acidity of the unautoclaved aliquots.

3. Sample No. 6 has the lowest acidity in all cases.

Sample No. 6 is the most stable because autoclaving and heating change its reaction least.

H. A. NOYES

PURDUE AGRICULTURAL EXPERIMENT STATION, LAFAYETTE, INDIANA

[3] R. T. = Room temperature.
A. = Autoclaved.
NA. = Not autoclaved.
H. = 95° C. or above.
(1) = No sample left for determination.
(a) 1.0% = requirement of 1. c.c. normal acid per 100 c.c.